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September 29, 1927

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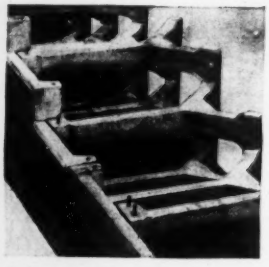
Around the Industrial Plant

This Cribbing Makes Ideal Retaining Walls



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DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

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JAMES H. McGRAW, *President*
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Civic Progress

PROGRESS toward efficient government is notoriously slow and painful. It is so slow that ordinarily we citizens find more cause for pessimism than for a hopeful outlook, and are apt to believe that progress is backward rather than forward. But the world does move, and signs of advance are to be discerned every now and then. Such a sign is the conviction of the mayor of Indianapolis on the charge of selling appointments. The crime charged is one that strikes at the root of representative government. Devoid of personal depravity though it may be, it cannot be tolerated if government and the citizen are to continue free and unperverted. Those who claimed to know Indiana politics have in the past said that they were almost without hope that reform would ever be achieved there. It now begins to appear, however, that bad politics, even though it smells to heaven, yet has to look forward to a day of reckoning.

Railroad History

RAILROAD history is pictured at the Baltimore & Ohio Centenary Exhibition now in progress on the outskirts of the city of Baltimore more completely than ever before attempted. The formal ceremony marking the 100th anniversary of the chartering of the Baltimore & Ohio Rail Road Co. took place early this year, but the railroad company felt that something more than a formal ceremony was desirable, that the closing of the first century of railroading in this country should be featured in such a way that the average citizen could be made to appreciate all that had been accomplished in that time. And so the company undertook to produce in pageant form a story of the railroad's past. What has been accomplished must exceed the expectations of those who first planned the work. The pageant goes far beyond the record of a single railroad. Many old locomotives and cars belonging to several railroads have been taken from their places of display and sent to Baltimore—some under their own steam—to stand alongside of great modern locomotives and cars which have come from as far afield as Canada and England; models of others are there on display along with many other kinds of railroad equipment, both ancient and modern. The whole collection is displayed in buildings or on tracks especially built for the purpose. The Baltimore & Ohio Co., on its own initiative, has produced an exhibition of a magnitude such as only the railroads acting as a group might have been expected to present. It is a remarkable undertaking.

Agitation and Organization

TOGETHER with others who have stood firmly for proper treatment of engineers in government service, *Engineering News-Record* is gratified to note some sporadic results of this agitation. In Philadelphia, a leading candidate for mayor, H. A. Mackey, included in his pre-nomination campaign a special advocacy of proper pay for engineers. "While committed to the strictest economy, I am not an advocate of false economy. Our city is committed to great engineering problems which must be successfully solved. * * * It is poor economy not to pay our engineers engaged in this highly important work a sufficient salary to retain them in the city's service." We are not inclined to be over-sanguine with respect to platform or pre-nomination pledges, yet we recognize in this statement at least an understanding of the situation; and this obviously is the necessary preliminary to action. Almost at the same moment, the New York authorities are said to be giving consideration to increasing the pay of engineering employees, who are admittedly underpaid and have gone on for a quite a number of years without revision of their schedule. The report carries a hint that the present attitude of the authorities is due to the fact that engineers are now well organized and are therefore entitled to claim consideration. Organization, then, is also an effective weapon. Coupled with continued agitation, it is the road to that recognition which is now too little given to engineering effort.

Jazz Bidding

LIKE chivalry, erratic bidding "is of no nation." For the big Nile River dam noted in our news pages Sept. 15 there were nine bids and they varied in amount from £1,976,555 to £3,134,344. Even our New York subway bids so frequently held up to scorn as horrible examples of extreme variation in bidding prices cannot excel this record of the Nag Hammadi barrage. And this is not a unique case. Our news columns this week tell of the bids received for a water-supply tunnel for the city of Mendoza in the Argentine; they were $1,204,000, $2,240,000, $2,600,000 and $2,850,000—a million difference between the lowest and the next lowest and the highest bid more than twice as high as the lowest. Truly this is an example of extremes not easy to be equaled by the most irrational of our American bidders. But the subject is not one for light treatment. Extremes in prices bid on the same work indicate a sickness in the contracting body. Whether we give the reason as ignorance of costs, incompetency in estimating, collusion to help a friend, playing a long shot or what not, the connotation is not creditable to contracting. There is business justification in bidding according to the market; the contractor must meet market prices or cease contracting, but there is no justification, on any basis of bidding, for a 100 per cent variation in prices. Speaking recently of a large contract for which he was soon to ask bids, the engineer expressed the hope that there would not be any jazz bidding. It seemed a rather apt definition of bidding as it is often recorded in our pages of contract prices. It is not, however, a definition of which contractors can feel proud.

Air Safety

EMPHASIZING further the season's black record of airplane fatalities, a large German commercial plane flying on one of the regular daily passenger routes in that country fell to its doom last week. This accident will doubtless tend to increase the alarm and distrust engendered by the long list of deaths which oversea flying claimed during the summer months. But the essential difference between commercial flying and adventure flying should not be overlooked. The brilliant deeds of the aerial adventurers are no doubt of great value, but their cost in human life has been exceedingly heavy, and this will always be true. Like the automobile racer, the oversea or other adventure flyer enters into a deliberate gamble with disaster. Commercial flying, on the other hand, has made a record of efficiency and safety nothing short of phenomenal. The facts were impressively reviewed by E. J. Mehren in *Engineering News-Record* of Aug. 4, and they are worth re-reading. In Germany alone more than 10,000 plane miles are flown every day and throughout all of last year only one passenger casualty was recorded, in nearly 4,000,000 plane miles. The excellence of this record is ample defense against the charge of undue hazard; and at the same time the record is so extensive that the perfection of the art rather than lucky chance must be given the credit. Undoubtedly we can look forward to a great future increase in the safety of flying; but even now—the latest accident to the contrary notwithstanding—the art has reached the point where it is virtually as safe as much of our daily life on the ground.

Dynagraph Cars

AN INJUSTICE was done to the late Dr. P. H. Dudley in an editorial in *Engineering News-Record* of Sept. 15, p. 415, by designating his dynagraph or track-recording car as a "gage tester in which a continuous record was roughly sketched on a moving tape." As a matter of fact, the apparatus on his car was very elaborate and accurate and produced large-scale charts of surface, line and gage conditions, closely identical with those of the new car mentioned. The apparatus of the few mechanical inspection cars of this type which have been built is based largely on Dr. Dudley's original designs. In the latest car, as described, the one outstanding feature of novelty is the application of the gyroscope to improve the records of cross-level of track. It is a matter of history that by periodical inspections with his elaborate apparatus and comprehensive charts Dr. Dudley was able to prove the value of his high rail with relatively small head (as now standard on the New York Central System) in comparison with shallow rails of about the same weight and having thick heavy heads. Furthermore, with this systematic graphical inspection, which included automatic marking of low spots and other track defects with jets of paint, he brought the tracks of the Boston & Albany, the New York Central and other lines to an exceptionally high degree of maintenance. Honor is due to Dr. Dudley as the pioneer in both the design and use of the intricate mechanism used for recording track conditions. It may be noted also that while the article in *Engineering News-Record* referred to both the original and the new cars as gage-testing cars, the gage is only one, and not the most important, of the track conditions tested and recorded by the apparatus.

Welding and Riveting

DISCUSSION of structural welding at the American Welding Society meeting at Detroit last week gave fresh evidence of the continued and increasing liveness of interest in this new art. Serious attention to its details on the part of structural men is only a year or two old, although brilliantly successful pioneer work dates considerably farther back. Welding, therefore, has been in the position of an unproven pioneer method, seeking introduction into a field where admirable and thoroughly dependable methods already exist—an undertaking of obvious difficulty. Yet consistent extension of welding to new types of structural work has been made from month to month in the past few years, and progress continues along the same lines with increasing momentum.

What the ultimate end of this development is to be cannot yet be foretold. This much has been made certain by now, however: There is no room to doubt that welding will stay in the structural field, and that it will have to be reckoned with permanently as part of the working equipment of the art.

A note sounded in the Detroit meeting by Joseph Matte, well known Detroit engineer, is significant in its application to the future of welding. He summarized his experience in applying welding to a large range of structural forms by the conclusion that welding will be found preferable to riveting in all cases where it offers some inherent advantage that is of value in the particular application proposed. Instances are: where joints must be tight; where maximum rigidity is sought; where it is desired to make an attachment to one side of a structural member without having access to the other side. These, of course, are illustrative cases only, and no doubt many others will develop as the actual use of welding is further extended.

Almost simultaneous with the meeting noted, there was a new instance of agitation against the noise of riveting hammers in city residential areas. We have previously noted earlier discussions of this subject. On the present occasion, an influential association of the property owners along a street of costly residences and apartments in New York City made public protest against the ceaseless daily din of riveting hammers and other construction tools, and asked the city authorities whether they could not eliminate or reduce the peace-destroying noise by regulation. One can easily appreciate their attitude, for even a day spent in proximity to a building operation where riveting is in process is a sore trial, and a month of it could make life seem hardly worth while. Yet in those progressive regions of a large city where active development of new buildings is in progress, the metallic drumming of the riveting hammer, near or far, is hardly ever silent. Welding presents the opportunity of eliminating the noise, and in this fact may lie one of the inherent advantages to which Mr. Matte referred. Even in the face of greater difficulty and cost, it may succeed in largely displacing riveting on city work because of its freedom from noise. When the public and its governmental authorities become less tolerant of noise than they now are, it is not inconceivable that they might prohibit riveting as an unwarranted breach of the peace, or so seriously restrict its use as to put it out of the running.

It is proper to bear in mind, however, that the remark quoted has wider application than to the question of weld-

ing. Every new method, process or device has to overcome the opposition of that which exists and which it would replace. It must overcome the initial handicap of question as to efficiency, dependability or cost, but in its very nature it will also possess characteristics and advantages which the older method does not possess. The natural development of its field of application rests on proper use of these inherent advantages of the new method. The whole art is enriched by the innovation, and the ultimate relation of the new and the old is likely to be found in their supplementing each other rather than in competing. Just as a new transportation facility, competing with an existing one, largely creates its own traffic and supplements rather than destroys the old facility, so a new technical method usually develops those uses and benefits arising out of its own characteristics and makes the resources of the art so much greater. So the ultimate place of welding in the structural field may prove to depend upon the new character of its service rather than on competition with riveting, and the two processes may co-exist and co-operate, to the general advancement of the structural art.

The Onward March of Zoning

ADOPTION by an overwhelming vote of a state constitutional amendment which authorizes city zoning in New Jersey, combined with the latest compilation of zoning statistics by the United States Department of Commerce, attest the onward march of zoning. So also does the Federal District Court decision in a Minneapolis case, solidly grounded on a notable series of decisions within the past few months rendered by the United States Supreme Court, all upholding the general principle of zoning in the most sweeping and conclusive terms. With four decisions already from the United States Supreme Court, each taking into account local conditions and specific complaints varied in character, chances for any successful attack on the fundamental principles of zoning are now small. The four decisions of the United States Supreme Court, beginning with that in the Euclid case abstracted in our issue of Dec. 2, 1926, p. 916, established city zoning beyond question as a valid exercise of the police power. At the same time they make it equally clear that zoning regulations must be reasonable if they are to withstand legal attack.

How popular zoning is in New Jersey is shown by the fact that, according to the federal statistics just mentioned, the state stands second in the number of zoned cities, having 75 on July 1, 1927, as compared with 93 in New York, the first state in rank, and 56 in Illinois, which ranks third. Notwithstanding this, a constitutional amendment in New Jersey was required to overcome the decisions of ultra conservative state courts which, although not declaring that zoning *per se* was unconstitutional, ruled that the specific zoning ordinances, as applied to cases at issue, did not come within the police power under either the state or the federal constitution. The Euclid and other United States Supreme Court decisions have taken the ground from under the New Jersey courts, so far as the federal constitution is concerned. The legislature and the voters at large have put zoning in New Jersey on a state constitutional basis. The popular vote of 3 to 1 in New Jersey was all the more notable because companion amendments to the constitution were badly defeated. New Jersey thus maintains its place in the zoning movement, despite its ultra-conservative courts; but it behooves its municipal legislators and boards of zoning appeal to have a care that both zoning ordinances and their administration are reasonable.

For the country at large, no change in municipal administration, unless it be the commission and commission-manager forms of charter, ever met with such widespread favor as zoning. Confined almost wholly to the past 11 years, 553 municipalities had adopted zoning up to July 1, 1927, the Department of Commerce figures show. In point of population, the 30,000,000 urban dwellers now in zoned cities is far in excess of the population in commission and commission-manager cities since 52 of the 58 largest cities of the United States are zoned, compared with which the number of cities under the commission and commission-manager plans is small.

Reverting now to the Minneapolis decision: It is both interesting and significant that the federal district judge who handed down a decision which unqualifiedly supported the zoning ordinance, so far as the law is concerned, apparently did so with reluctance. He said: "As a matter of justice and good morals, it would seem that a city should pay for damages occasioned by an ordinance of this kind, where no substantial present injury is being done the public by its existing use, and where the classification prohibiting the use is largely a matter of convenience and not of necessity." Yet he was compelled, in the light of recent decisions of the United States Supreme Court, one of which upheld the very Minneapolis ordinance in question, to uphold it in the case before him. This, too, notwithstanding the fact that he interprets the evidence as showing that the property of the four owners who contested the ordinance would be worth "from five to eight times" as much for industrial as for multiple dwelling house purposes—the latter being the classification in question. Opinions as to the same general reduction in value were endorsed by the United States Supreme Court in the Euclid, Ohio, case mentioned at the beginning of this article.

The utter impracticability of substituting the opinions and feelings of court judges for those of city plan commissions and city councils who are in the first instance entrusted with the decision as to zoning property under the police power is acknowledged by the judges who handed down these federal decisions, as is brought out in the summary of the two district court decisions in the current news section of this issue.

Another point of interest noted in the Minneapolis decision is that for some years there has been on the statute books of Minnesota a provision affecting the three larger cities of the state under which piecemeal zoning could be effected by condemnation proceedings. This does not seem to have given satisfaction in the instances tried. Authorities on zoning agree that condemnation proceedings are utterly inadequate to meet the zoning needs of our cities and the larger city planning of which zoning is an essential part, and that instead reliance must be placed on the exercise of the police power.

With the sanction of our federal courts and of nearly half of the higher state courts, the more conservative judges in other states are bound to yield, or else the state constitutions will be amended, as in New Jersey. This will add to the rapid progress of zoning, but, as already suggested, will make even more necessary the exercise of reasonable discretion in the framing of zoning ordinances and in their administration by building departments and boards of appeal.

Large One-Story Industrial Building; 2400x500 ft.

Stock, Manufacture and Storage of Refrigerator Cabinets All Provided on One Floor—Alternate Monitor and Flat Roof Spans—Conveyors Serve Warehouse

By Nelson J. Bell
Chief Engineer for Schenck & Williams, Architects, Dayton, Ohio

IMMEDIATE doubling of output capacity and probable tripling of its capacity within two years was the problem faced in the spring of 1926 by the Delco Light Co., Dayton, Ohio, which was then producing 1,000 of its Frigidaire home refrigerator units daily, besides farm lighting units and small house pumps. Each refrigerating unit consists of a cabinet, compressor and cooling coil. All of the above were made at the Dayton plant, except that the cabinets were made at Moraine City, six miles south. Both plants were working at full capacity, but there was no room for expansion at Dayton, while at Moraine City there was plenty of land available. With the lighting units and pumps transferred to a second Dayton plant, acquired from a subsidiary company, the first plant was altered and equipped with machinery and conveyors so as to have the desired output capacity for compressors and coils.

Moraine City Plant—For cabinet production the plant at Moraine City was enlarged to give an output capacity of 2,000 cabinets per 9-hour day, but this capacity can be increased 50 per cent under pressure to meet a heavy demand. The railway trackage and facilities provide for a shipping or outbound capacity of about 100 cars daily, while the inbound or receiving capacity is considerably higher. As the cabinets are cumbersome to handle and require large space for manufacture, this plant was expanded on one floor level, the main manufacturing shop and warehouse having now the great size of 2,400x500 ft.

At Moraine City the company's property consists of a strip of land about a mile in length and 600 ft. wide between the C., C., C. & St. L. Ry. and the Springboro pike, together with a tract 1,680x855 ft. west of the railroad and extending to the abandoned Miami & Erie canal. South of the chief transverse driveway in the main portion, opposite Edison St., as shown in Fig. 1, are the wood and cork departments and employment office. On the north are the manufacturing and stock building 1,800x500 ft. and warehouse, 600x500 ft. (forming one structure but separated by a fire wall), and a 700-ft. storage yard with miscellaneous small buildings. Beyond this yard, a six-story concrete building will be erected for the manufacture of compressors and coils when further expansion becomes necessary.

Beyond the railroad are the boiler plant, coal storage space and two covered concrete reservoirs of 200,000 and 500,000 gal. capacity for fire service; also the acetylene generator house, which is remote from the main buildings in order to minimize damage in case of explosion. There is room for a duplicate boiler house and for a power plant. At present steam is supplied for heating and process purposes only, electric current for power and light being purchased from the Dayton Power & Light Co. A tunnel under the railway carries the steam and return pipes, water pipes and a wood-waste conveyor.

Prior to the recent expansion, the manufacturing part of the plant consisted of six principal buildings aggregating 510,000 sq.ft. of floor area. The main building, 270x1,000 ft., was of concrete construction, as described in *Engineering News-Record*, April 4, 1918, p. 667, and this forms the southwest portion of the present enlarged structure. With a warehouse 250x360 ft. and a foundry 100x300 ft., all placed end to end, the total length was 1,660 ft. The foundry has been removed. The wood mill, doubled in size, is 200x400 ft.

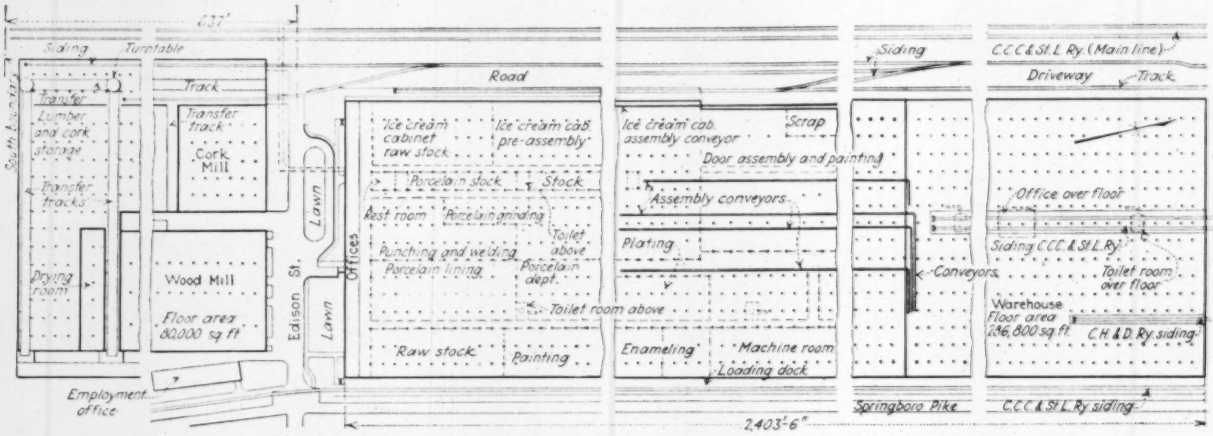


FIG. 1—INDUSTRIAL PLANT WITH MAIN BUILDING 2,400 X 500 FT.

Large Main Building—The great manufacturing and warehouse building 2,400x500 ft., all under one roof, is essentially a steel-frame expansion of the concrete structure erected in 1917. It follows the same general design, but the roof has a 2-in. wood deck instead of concrete slabs and the concrete floor is on solid fill, instead of being over a shallow basement.

For this new portion of the building, steel framing was adopted instead of concrete because of lower cost and greater speed of construction. The panels are approximately 20x30 ft. In structural design, it is composed of

units, each four 30-ft. bays in width, with one 30-ft. bay between each pair of units. For the roof, each unit consists of a Pond-type monitor two bays wide and a flat roof over each side bay. The connecting or intermediate units have smaller Pond-type monitors. This simple roof construction can be expanded indefinitely, and it provides much better light and ventilation than the saw-tooth type of roof. Fresh air enters at the low monitors, while foul air and gases are exhausted through the high monitors. Toilet rooms are placed overhead in the larger monitors, thus leaving a clear floor space throughout the building.

The general design is shown in Fig. 2, while details of a typical bay are given in Fig. 3. Steel columns of 8-in. H-beams have transverse 18-in. I-beam girders framed between them and secured by knee-braces. These bents are spaced 20 ft. c. to c. to allow the use of purlins of economical size, and the bents are connected by purlins of 9-in. channels framed between the girders. The clear headroom from floor to girders is about 16 ft.

warehouse. Two railroad sidings and one electric railway siding enter the warehouse, where the cars are loaded entirely under cover. The warehouse is unusually large because of the seasonal character of the demand for the product, as a large portion of the winter production must be stored until summer.

The wood mill, paint storage, oil storage and maintenance storage buildings are all of the same general design, having floors laid on the ground, walls of brick and steel sash, and plank roof decks on steel purlins and steel trusses, the trusses, spaced 20 ft. c. to c., are supported on steel columns.

Lumber and Cork Building—The lumber and cork storage building was designed to accommodate a special method of handling lumber and cork on trucks which run on tracks of 42-in. gage, laid on the concrete floor. There are four storage tracks in each bay. Two railroad sidings enter the building, the lumber and cork being unloaded under roof and piled on the trucks. Transfer tables carry the trucks to the desired storage tracks and

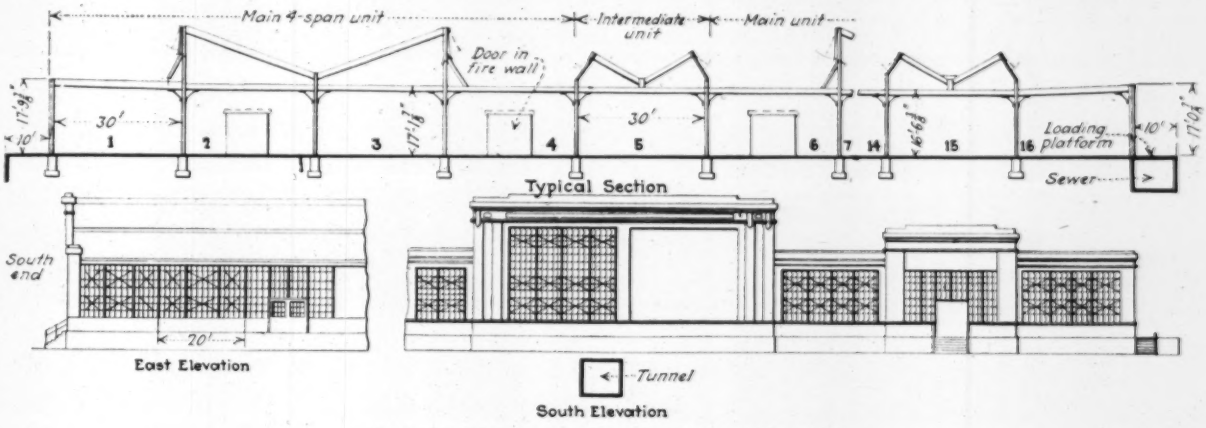


FIG. 2—STRUCTURAL FRAMING AND ROOF BAYS

The roof trusses also are of steel, with 9-in. steel channels for the purlins.

Light and Ventilation—All of the steel framing and the wood ceilings are painted to improve the lighting. Steel sash forms the greater portion of the walls, the remainder being of red brick and gray stone. A brick fire wall with tin-clad doors separates the warehouse from the manufacturing department. The ventilating sash in the roof monitors is operated electrically in 200-ft. sections, while the ventilating panels in the side-wall windows are operated by hand. For electric lighting, drop fixtures with reflectors are spaced 10 ft. c. to c. in each direction. These fixtures are 12 ft. above the floor and each is provided with a 150-watt lamp, thus giving an illumination of 1½ watts per square foot of floor.

Handling Material—A 10-ft. loading platform extends the entire length of the building on either side, and a tunnel through the center, also extending the entire length, gives access to the transformer vaults and compressor room. Raw stock is brought in on two railroad sidings which run along each side of the building for its entire length. The various stock and sub-assembly departments are so grouped that materials move directly from the receiving rooms to the assembly conveyors. The cabinets are assembled and packed ready for shipment on the conveyors, which also carry them into the

also from storage to the tracks leading into the drying room and the lumber and cork mills. This building is constructed as a series of units placed side to side, each unit consisting of a 30-ft. flat roof monitor and two 30-ft. side bays. The roof construction consists of 2-in. wood on steel purlins and steel beams, supported on steel columns. Bents are 20 ft. c. to c., or 22 ft. at the transfer tracks. The walls are of brick to a height of about 4 ft., with steel sash above.

Boiler Plant—The boiler house built in 1917 was about 100 ft. square, with concrete frame, including the roof, and faced with brick. It consisted of a center bay with a Pond roof truss and two side bays and had eight 250-hp. boilers with a 200-ft. brick smokestack. Coal and ashes were handled by a monorail carrier with clam-shell bucket. The recent expansion consisted of doubling the length of the house; installing four 722-hp. boilers, building a new stack, and new stack foundations for future extension. This building is of the same general design as the original house, but is of steel construction with a concrete tile roof.

The new coal handling plant consists of a track hopper, skip hoist, crusher and overhead bunker which is housed in a brick structure at the back of the boiler house. Coal is carried to the automatic stokers in a weighing larry traveling along the center of the house. Ashes are dropped from the pits into cars, which in

turn dump into a skip hoist which carries them to a bunker over the railroad siding. Coal is distributed to the storage yard and reclaimed therefrom by a drag scraper hitched to a tail car which moves on a circular track.

For effective distribution and control of steam, the buildings are divided into convenient sections, each provided with a reducing valve and a vacuum pump. Steam brought from the boiler house at 150-lb. pressure is reduced to 20-lb. in each section. The pumps separate the air from the condensation, discharging the air into the tunnel and the water into a main return which carries it back to the boiler house.

Unit Heaters—On account of the type of the buildings and the large areas of glass and exposed roof, the heat losses are large and special attention was paid to heating. The original main building was heated by air taken from outside, tempered at the intake, and forced by two large fans through underground ducts to reheating chambers, whence it was distributed under the floor to risers discharging into the room at 8 ft. above

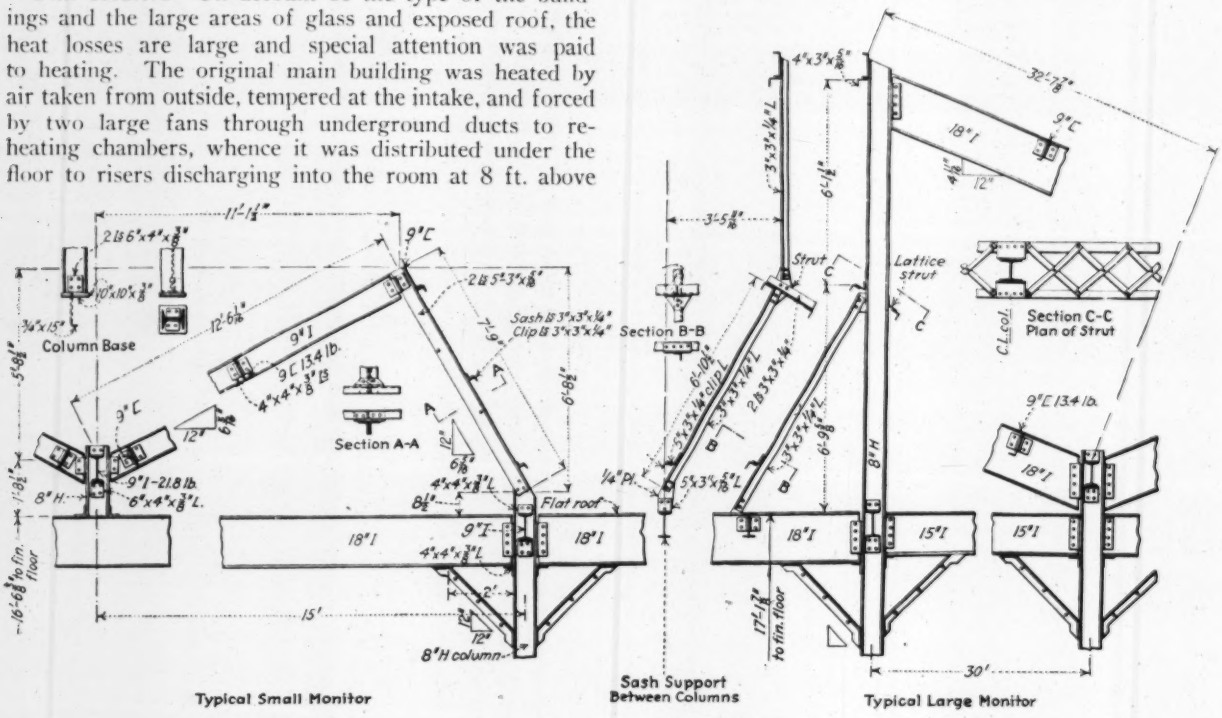


FIG. 3—TYPICAL ROOF DESIGN

the floor. Temperature was regulated by thermostatic control. This system remains in the old main building.

In all new buildings, heating is accomplished by means of unit heaters, set on the floor and recirculating the air. Each unit consists of a motor-driven fan and a steam radiator connected to the overhead pipe lines. In order not to occupy too much floor space these unit heaters are comparatively large and are spaced about 160 ft. apart. Each heater is designed to furnish 20,000 cu.ft. of air per minute at a temperature of 120 deg. F., and takes care of about 16,000 sq.ft. of the building. Temperature is controlled by thermostats. Where air is exhausted from the rooms, as in the wood mill, cork mill and painting and porcelain departments, unit heaters are placed to make up for the air exhausted.

Fire Protection—The plant is protected by a sprinkler system and by hydrants placed at frequent intervals. Water from wells driven into the gravel stratum is forced by electrically driven pumps into an underground pressure tank, whence the water for drinking and other uses as well as for fire protection is taken. Water for fire protection flows to the two concrete reservoirs with a combined capacity of 700,000 gal. Steam-turbine pumps force the water into the sprinkler system, where constant pressure is maintained by a 50,000-gal. elevated tank. Thus a reserve of 750,000 gal. is maintained in addition to the normal capacity of the well pumps.

Sewers and Drainage—Storm and sanitary sewers are separated, the mains of both being placed in Edison St with branches running north and south. Both sewers are carried west to the Miami River, about ¼ mile from the plant. The space under the east loading dock of the main building was excavated and provided with a concrete floor to form a main lateral storm sewer for the east half of the building. A storm sewer existed along the west side for 1,600 ft. and this was extended to the north end. Down-spout lines are carried across the building under the floor to these two sewers. Street and yard drainage is taken care of by catch basins and laterals to these sewers. Sanitary sewers within the building are taken under the floor across the building to a main sewer immediately west of the building and running its full length. South of Edison St., storm sewer laterals pick up the down-spout and yard drainage and carry it north to the main sewer. Sanitary sewage is carried similarly from the toilet rooms to the main sewer.

Railroad Tracks—Extensive trackage is provided to accommodate the large number of cars necessary. A main running track branches from the north-bound track of the C., C., C. & St. L. Ry. at the north end of the property and extends along the west fence line, branching at Edison St. so that two tracks extend into the lumber storage building to form incoming freight tracks. A branch crossing the property near its north end and extending along the east side of the future six-story building and the present main building, serves for incoming freight. At the south end of the main building,

this track joins a track connecting to the C., H. & D. Ry. which is an electric interurban line. Another siding extends along the west side of the future six-story building and then into the warehouse, where it branches into outgoing freight tracks.

A third siding parallels the main running track and extends along the west side of the main building to its south end, serving as a second incoming freight track. A passing siding is inserted along the main running track and crossovers are also provided to facilitate the movement of cars. Coal is brought to the boiler plant by a siding from the southbound track of the railroad at the south property line. A second and independent connection with the C., H. & D. Ry. is provided for outgoing freight, with a single track into the warehouse. In all there is an aggregate of about five miles of standard-gage track in the plant. Tracks in the warehouse and along the loading docks are about 4 ft. below the floor so as to bring the car platforms level with the floor. Those in the lumber storage building are at the floor level, as the lumber unloaded from the cars is placed on plant trucks.

Designers and Builders—This entire project was carried out between June, 1926, and January, 1927. It was designed by Schenck & Williams, architects, Dayton, Ohio, in co-operation with T. B. Fordham, works manager, and R. V. Polen, master mechanic, of the Delco Light Co. The construction was divided between Charles H. Shook and the Denis-Hunt Co., Dayton, Ohio, under the direction of the construction department of the Fisher Body Co., of which H. E. Beyster is chief engineer.

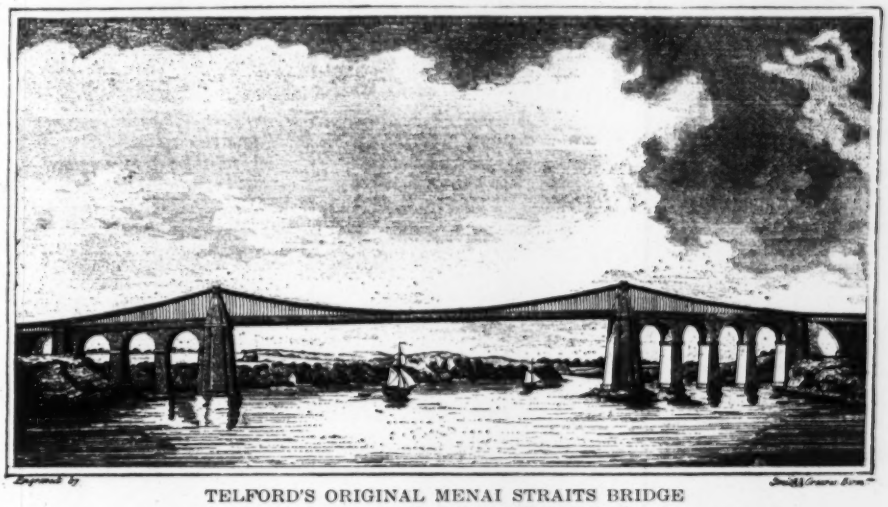
California Makes Highway Bridge Inventory

An investigation of every bridge on the California state highway system is being made under the direction of C. E. Andrew, highway bridge engineer in that state, with a view to classifying and reporting on the condition of each structure. The adequacy and safety of the bridges under present and prospective traffic will be considered and a rating will be made to establish the safe maximum loading in each case. In a preliminary report on this work Mr. Andrew points out that of the 600 bridges of various types and design on the state highway system the greater number were built by counties prior to the advent of the State Highway Commission and hence little is now known about them. Some are in a dangerous condition structurally, he says, others are depreciating rapidly and may soon be dangerous, and still others will be safe for many years to come. No such survey has ever been made before in California but it is urgently needed because of the millions of dollars that the state now has invested in these structures and the need for assigning maintenance as required.

Menai Straits Suspension Bridge May Be Removed

PLANS have been prepared for a concrete arch highway bridge to cross Menai Straits, between England and the island of Anglesey, on the location of the famous suspension bridge built by Telford in 1826. The old structure has served continuously since its erection, and to this day constitutes the only means of highway communication across the straits.

The Menai Straits bridge has a central suspension span of 580-ft. length between centers of main piers, carried by a wrought-iron chain with sag of 43 ft. 4 in. It has been considerably overloaded in recent years, due to the substitution of a heavier floor for the original light wooden floor, and is now to be replaced in order to meet modern traffic requirements. An examination made for the Ministry of Transport showed that it would be practically impossible to strengthen the old bridge, according to an article in *Engineering* of July 1, and the design of a new bridge was therefore undertaken. The new structure is planned to be built of reinforced concrete, as it must be maintained by the local communities and these do not wish to be burdened with the maintenance of a bridge that would require frequent repainting. A design has been worked out at the order of the government by Considère Constructions, Ltd., of London, which contemplates a single arch span, to spring from the old main piers (somewhat reinforced) and to carry a new roadway at about the level of the old one. For navigation clearance, the arch must be placed above the roadway, the required underclearance being 80 ft. high on a width of 460 ft. The arch will consist of two ribs, each comprising an upper and lower octagonal member and a vertical connecting web. The floor would consist of precast latticed floorbeams, hung from the arch by steel suspenders.



TELFORD'S ORIGINAL MENAI STRAITS BRIDGE
From an engraving in an old guide book
Minor changes were made in later years. A concrete arch bridge is planned to replace the 101-year-old suspension structure.

The above view of the old Telford bridge is taken from an old guide book, published not long after the completion of the bridge. The general appearance of the structure has been retained, however, despite various changes made in the course of its century of service.

Experience in Destroying Sewage Screenings by Burning

A Review of Records at the Long Beach Disposal Plant—Notes on Incinerator Operation Using Natural Gas Fuel

By Robert A. Appleton
Formerly Superintendent of Sewage Disposal, Long Beach, Calif.

THE sewage screening and screenings disposal plant at Long Beach, Calif., is located not far from the bathing beach of a popular seaside resort and hence has to satisfy strict operating requirements to avoid nuisance, odors or unsightly appearances. The usual requirements of convenient and economical operation also obtain, and therefore this plant has received particular care both in matters of design and in methods of operation. The following notes summarize the writer's observations, particularly as to disposal of screenings, on the operation of this plant, for a number of years, during which he had direct contact with it. Construction of the screening plant was described in *Engineering Record*, May 20, 1916, p. 664, and in *Engineering News*, May 4, 1916, p. 836. Description of the remodeled incinerator appeared in *Engineering News-Record*, July 24, 1924, p. 136, and tabulated operating statistics were published June 2, 1927, p. 911.

The reconstruction in 1924 included the installation of two Dorrco screens, each 8 ft. in diameter and 8 ft. wide, with screenings elevators and pneumatic ejectors. The old Riensch-Wurl screen, 14 ft. in diameter, was shut down Dec. 20, 1924, and while it has been kept since that time as a standby, it has not been used thus far.

The Dorrco screens are of sturdy construction, well balanced and fitted with manganese bronze plates, $\frac{3}{16}$ in. thick. The size of the milled slots in the screen plates is $\frac{1}{16}$ x 2 in. Each screen is independently driven by an electric motor through suitable enclosed worm gear speed reducers. Bronze seal rings which are capable of close adjustment prevent unscreened sewage from entering the effluent channel. Each screen has a capacity of 12 m.g.d. and the city sewage flow is such that with this installation one screen can be held in reserve at all times so that 24-hr. operation is easily maintained. Maintenance cost of the Dorrco screens has been negligible.

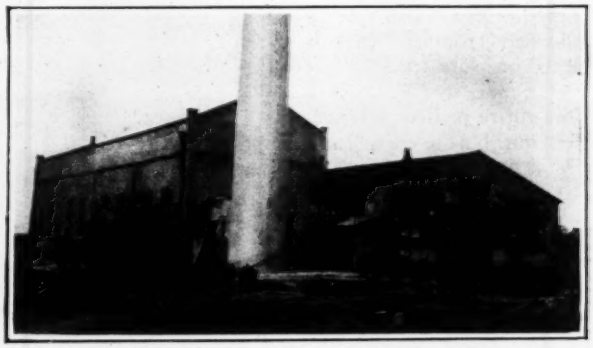
As was anticipated, the Dorrco screens removed more solids per million gallons of sewage than did the old equipment. This justified remodeling the old incinerator to handle a greater capacity.

Records of operation of the remodeled incinerator are available for an 18-month period ending June 30, 1926, including hourly observations of the furnace temperature, of CO_2 and of the rate of sewage flow. The weight of each charge of screenings was taken as it went into the incinerator and the time of charging was also noted. The night operator read the gas, power and light meters.

After nearly two years' experience on a 24-hr. basis of operation it was decided to build an additional incinerator unit to insure continuous operation of the incinerator and thus to put the entire plant on a 24-hr. basis. In the design of this new unit the Dutch oven type was adhered to but plans were changed so as to make a down draft throughout. By making the over-all length of the new unit 16½ ft. it was possible to place it alongside the old incinerator, outside the existing building, and to utilize four backstays already in place. Holes were burned in these backstays to permit circulation of air between the two incinerator units. With a slight change in the hopper bottom of the 250-cu.ft. screenings tank it was possible to add a new chute so that screenings could be delivered to either unit. The new chute operates successfully on a slope of 45 deg.

The new incinerator grate unit is 4 ft. wide and 8 ft. long, made of cast-iron fire bars with ⅜-in. air spaces. Screenings are discharged onto the grate near one end through an opening in the incinerator side wall. Combustion is started at this end of the furnace with natural gas. Air for combustion is mixed with the fuel by means of a blower delivering to two nozzles, set in tuyeres in the end wall on either side of the fire door.

At the same level as the fire grate and forming a continuation of it is a firebrick bed, 5 ft. wide and 6 ft. long, on which the screenings, after being raked or pushed forward by the operator, are completely incinerated. This firebrick bed, which is of the same construction as the furnace roof, forms the floor of the combustion



SEWAGE SCREENING PLANT AT LONG BEACH, CALIF.

chamber and the roof of the ash pit beneath. Lining in the combustion chamber and the ash pit is of refractory material and all walls and roofs were insulated with a refractory concrete preparation.

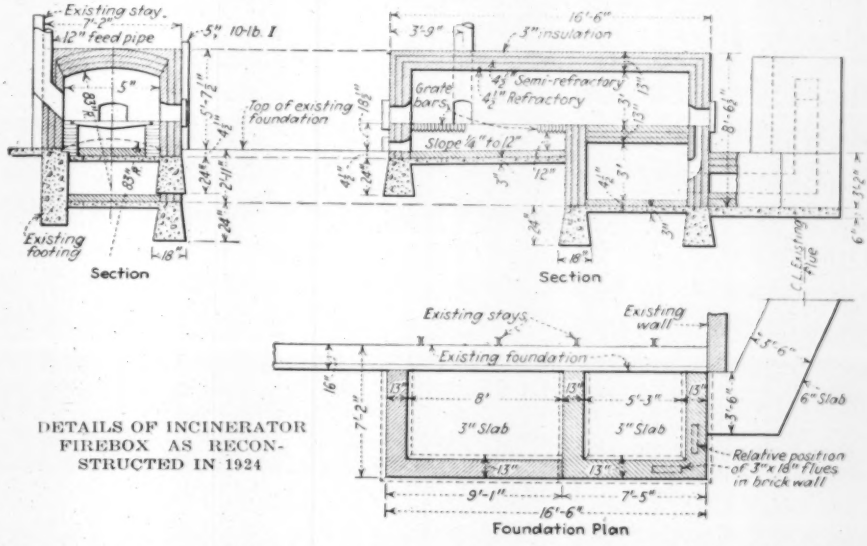
The incinerator has two ash pits at different levels, one under the grate and the other under the combustion chamber, separated by a 13-in. wall. The pit under the grate has a drain connected to the sewer on the influent side of the fine screens. The pit under the combustion chamber has provision for removing ashes through an 8-in. pipe in which water can be used to sluice them down onto the ocean beach. The roof of the incinerator is an arch of 83-in. radius with a 6-ft. rise at the center. The entire structure is suitably braced with backstays and longitudinal angle irons, and is covered on three sides with steel plates.

The six firing doors in this furnace are made of channel steel frame filled with precast cement and refractory concrete. Each door is suspended by steel cables over two counterbalanced, 6-in. pulleys. Construction on this new incinerator unit, excepting only the steel chute from the screenings hopper, was done by operators at the plant. The total cost of the additional unit built in this way was about $2,500.

In the incinerator as remodeled in December, 1924, there were placed an electric indicating pyrometer and an electric CO_2 indicator. These have given excellent service without any expense for maintenance. Space

was provided in the pyrometer for the attachment of eight thermo-couples. An additional platinum-rhodium high temperature couple was placed in the roof of the combustion chamber of the new incinerator unit and a base-metal couple was put in the flue near the stack. Provision was made also for taking continuous samples of flue gas, using the existing CO_2 indicator.

During the 18 months ending June 30, 1926, records showed a steady improvement in operation, which speaks well for the interest taken by the operators and their attention to duty. During this time seven different men operated the incinerator; these were three regular operators and their relief man, the maintenance man who served when regular operators were absent, and two new operators who replaced men that quit. These operators were all trained both in fuel economy and in the desirability of burning screenings as soon as possible after their removal from the sewage. The rule is incineration within 24 hr. after removal.



DETAILS OF INCINERATOR FIREBOX AS RECONSTRUCTED IN 1924

The operation of burning the screenings, which have a moisture content of 85 to 88 per cent, is substantially as follows: A charge of 2,000 to 4,000 lb. is dumped onto the grates after remnants of the previous charge have been raked onto the firebrick bed where they are completely incinerated. A few ashes left on the grates facilitate drainage of the fresh screenings. At this time the temperature in the combustion chamber is usually about 1,850 deg. F. The introduction of a mass of wet screenings lowers the temperature to about 1,600 deg. F. for a brief period until the top surface of the screenings becomes ignited. With a charge of not more than one ton the combustion chamber temperature seldom drops below 1,700 degrees.

The steam and gases given off by the mass of wet refuse suddenly dumped into a high temperature chamber are taken care of by the radiant heat of the refractory at the opposite end of the incinerator. From the moment of introduction onto the grate, the screenings drain from the under side and in a very short time they are burning merrily on top. After 20 to 30 min., depending on the nature of the screenings, the operator rakes or pushes a portion of the partly burned screenings from the top of the pile onto the firebrick bed. The portion left on the grates is stirred up by the rake and left to burn for about 30 min. more. This procedure is followed until the charge is completely burned.

Burning practice at any plant should not be decided upon until the character of the screenings has been studied. At Long Beach, the clinkering point of the screenings was about 1,950 deg. F. Consequently operators were instructed to keep temperatures below this point. The highest temperature observed was 2,430 deg. F. which resulted in the formation of a hard, vitreous clinker, difficult to remove when hot, but very brittle and, when cold, easily broken without damage to the firebrick.

An important point to remember in operation is the necessity for removing all partly burned screenings to the firebrick bed before a charge of wet screenings goes onto the fire grates. The reason for this is that screenings that have been subject to fire but not completely incinerated are extremely difficult to burn if allowed to soak up moisture from fresh screenings.

In the remodeled incinerator the average rate of burning was 10.5 lb. of screenings per minute. In the new unit the rate is much greater and the amount of fuel used to burn 1 cu.ft. of wet screenings has been cut in half. Complete figures are not yet available on the operation of the new unit as it has been in service only since early this year. A fair comparison with results in the remodeled incinerator should cover operating records for a period of at least 12 months.

Sewage at the Long Beach plant has been usually of such nature that the screenings removed averaged 30.7 cu.ft. per million gallons. Each year, however, large quantities of refuse come periodically from canneries. Refuse from tomato canneries comes between August and December and that from the fish canneries causes an additional burden between December and April With the fish canneries in operation, as high as 11 tons of screenings have been removed and incinerated in 24 hr. This necessitates fast work on the part of the operators and fortunately is only a periodical load. As an example of peak loads on the screening plant, during an 11-day period in November, 1925, the screenings removed averaged 45 cu.ft. per million gallons of sewage. This unusual load was caused by cannery wastes.

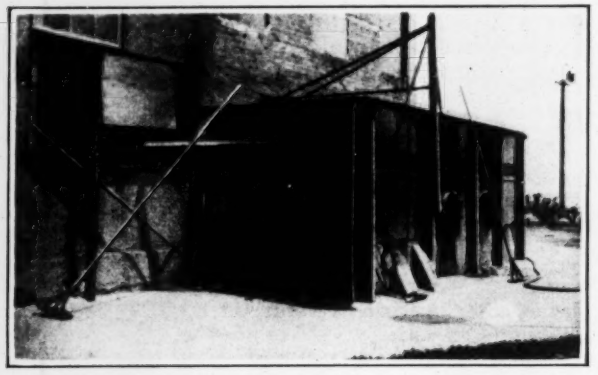
During the fiscal year ending June 30, 1926, a total of 80,220 cu.ft. of wet screenings was incinerated with 8,493,200 cu.ft. of natural gas as fuel. Although no actual charge was made for this gas, which came from the municipally owned plant, a rate of 20c. per thousand was considered a fair one to use when making up figures on the cost of operation as this rate would have been charged to a private gas consumer using like quantities. On this basis the cost of burning 1 cu.ft. of wet screenings was: fuel 2.15c. and labor 1.875c., a total of 4.025c.

The labor cost was taken as 25 per cent of operators' time. The natural gas has an average heat content of 1,150 B.t.u. per cubic foot. It required 105.8 cu.ft. of

gas to incinerate 1 cu.ft. of wet screenings during the fiscal year 1925-26. Some 8,760 temperature readings were taken inside the combustion chamber; of these, the highest was 1,690 deg. F. and the lowest was 1,561 deg. F. Temperatures in the flue near the stack averaged 860 deg. F. An analysis of the ashes removed, which varied from 0.5 to 1.15 per cent of the weight of screenings burned, showed the following percentages: Silica (SO_2), 46.14; phosphoric acid (P_2O_5), 10.82; potassium oxide (K_2O), 2.85; sodium oxide (Na_2O), 1.82.

After making a few changes in the old incinerator it is proposed to hold it in reserve. The 4½-in. refractory lining in the combustion chamber is still in good condition, but part of the back arch has required patching. This was formed of 9-in. blocks which apparently are not as durable in an incinerator of this type as firebrick of standard shape and size.

In excavating the foundation for the new incinerator unit some of the screenings buried 27 months before were uncovered. These had been placed in pits about 4 x 12 ft. in plan and 8 ft. deep, a few feet above the high tide line, and were covered with about 2 ft. of sand. For the first 2 ft. these screenings were comparatively dry and gave off a mild odor. Matches, hair, rags, paper, etc., were plainly visible and the print on pieces of news-



NEW INCINERATOR UNIT COMPLETED EARLY IN 1927

paper was easily decipherable. Underneath was a soggy mass, in appearance similar to pig muck, but with a much worse odor. This muck was burned in the incinerator but used more gas than do fresh screenings.

Residents in the vicinity of the Long Beach plant have made no complaints regarding its operation although the nearest houses are only 75 ft. from the incinerator stack. The ashes are used to make fills around the plant as much as possible or are given to anyone who will haul them away. They are found useful particularly in making new lawns, probably because they loosen the adobe soil and retain sufficient moisture to prevent packing.

In summing up observations on the incineration of sewage screenings it should be borne in mind that the most economical results will be obtained when the incinerator is operating at or about 75 per cent of its rated capacity. Because of the number of handlings involved and the need for disposal in an inoffensive manner the incinerator unit should be at or near the screening plant. With properly designed equipment screenings are handled once only between the screens and the incinerator. A closed storage hopper might be used in which screenings could be collected for a week or more without nuisance, but all such features of a plant should be worked out in complete detail before construction.

Mountain Revision on Main-Line Railway in India

Switchback Avoided and Train Loads Increased by Double-Track Cutoff with Tunnels 34½ Ft. Wide—Electrification

BY CONSTRUCTING a cutoff line only 2.11 miles in length, but involving heavy work and a 3,080-ft. tunnel of exceptionally large cross-section, the Great Indian Peninsula Ry. will eliminate a switchback or reversing station which seriously restricts freight-train loads on a busy double-track main line. The line revision will enable train loads of 1,100 tons to be handled, while the present limit is 500 tons. This limit is mainly in the length of trains, since the switchback lies along the crest of a narrow spur and it is stated by the engineer that its extension would require a four-track structure 800 ft. long and 135 ft. high at its outer end. With the longer and heavier trains there will be greater traffic capacity and a reduction in train mileage and running time. There will also be a great saving of time at the Karjat and Lonavla stations at top and bottom of the 15½-mile section operated by banking or pusher engines, as freight trains now have to be broken up and reassembled.

In the original development of a railway from the port of Bombay to the great central plateau of India the line had to be carried up the precipitous bluffs or ghauts, which rise 2,000 to 3,000 ft. high at about 50 miles from the coast. The railway was built as a double-track line on the Indian standard gage of 5 ft. 6 in. Its construction was a stupendous task when the work was done in 1856-1863; only native labor was available, and from 25,000 to 42,000 men were engaged on the grading. Long ruling grades of 1 in 37 or 2.7 per cent were required, with numerous long and sharp curves, many tunnels and masonry viaducts and retaining walls. Switchbacks were introduced at two points, the Thul Ghaut on the line eastward and the Bhore Ghaut on the line southeast to Poona. The former was eliminated by realignment in 1913 and the latter will be eliminated by the work now in progress. The general situation is shown by Fig. 1.

In the broken country at the Bhore Ghaut, the

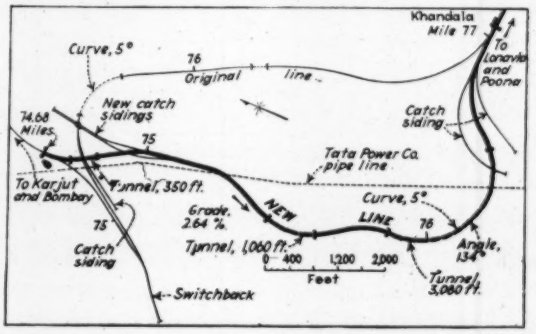


FIG. 1—CUTOFF ELIMINATES SWITCHBACK: GREAT INDIAN PENINSULA RY.

ascending line beyond the switchback passes through the point of a long mountain spur and follows along the precipitous slope of its east face to reach Khandala. The new line passes under the switchback by a short

tunnel, follows along the west slope of the spur and finally pierces its base by a long tunnel on a curve, rejoining the old line at Khandala.

Catch Sidings—As a protection to traffic, catch or trap sidings with spring switches are provided at four points on the 15½-mile incline, and two of them occur on the cutoff. These sidings are placed in both tracks and are designed to take care of unbraked runaways at a speed of 60 m.p.h. At the Khandala catch sidings, the one on the ascending track is 2,100 ft. long, running level for 650 ft. from the switch and then rising on a 5 per cent grade for 750 ft. and 10.7 per cent for 700 ft.

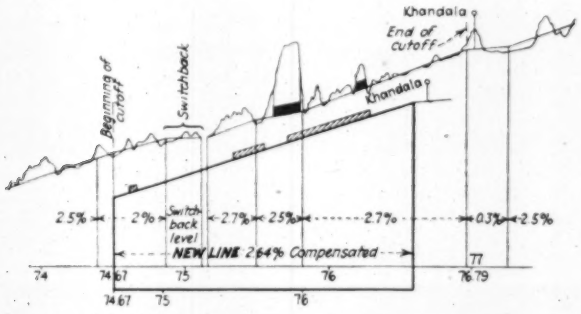


FIG. 2—PROFILES OF OLD AND NEW LINES

At the lower or Battery Hill sidings, the one for the ascending track is level for 1,050 ft., and then on an 8 per cent grade for 1,350 ft. The one for the descending track rises at 2½ per cent from the switch for 400 ft., then 6½ and 8 per cent for 600 and 900 ft. successively.

Comparison of Lines—On the present line the maximum grade is 2.7 per cent, not compensated for curvature, for a length of 1¼ miles. On the remainder of the ghaut or incline section, where pusher engines are used, 15½ miles, the maximum grade is 2.5 per cent, equivalent to 2.64 per cent compensated for curvature. On the new cutoff the maximum is 2.64 per cent, compensated. The sharpest curves are 5 deg. 50 min. on the old line and 5 deg. on the new line, the latter having transition curves about 270 ft. long. This cutoff, 2.11 miles in length, will save ¼ mile in distance but will make little saving in curvature and no reduction in summit elevation. Its main purpose is to eliminate the switchback as a hindrance to traffic and a restriction on train loads. The two profiles are shown in Fig. 2.

On this part of the line the traffic averages ten passenger trains and seven freight trains in each direction daily. Freight traffic daily over the division averages 3,136 tons westbound and 3,485 tons eastbound, but it is estimated that by 1932 these figures will be 4,770 and 5,300 tons respectively.

Large Tunnels—Three tunnels are required, 350 ft., 1,160 ft. and 3,080 ft. in length. All are on curves of 4½ and 5 deg. and the long tunnel turns through an angle of about 140 deg. To accommodate broad-gage rolling stock 12½ ft. wide and 15½ ft. high, and to give it ample clearance on the curves, where tracks are spaced 16 ft. 7 in. c. to c., the tunnels have a clear width of 34½ ft., and a headroom of 22 ft. 10 in., from head of rail to crown of arch. This section, shown in Fig. 3, is believed to be the largest for any railway tunnel in the world. It is expected that all excavation will be in solid trap rock, with little water. An alternative section for soft ground is also shown. Owing to the danger of rock falling from such a great width of roof, the tunnels will be lined. For the longest tunnel there are two intermediate working shafts. The contractor is driving a top heading using compressed-air drills, with electric power and electric locomotives, current being supplied by the Tata Hydro-electric Co., whose power station at Khopoli is only a few miles distant.

For the tunnel section in hard ground, the excavation is 836 cu.ft. per running foot, including 10 cu.ft. for the side drains. The arch requires 62 cu.ft. of masonry per foot. For the alternative section in soft ground, the excavation is 1,145 cu.ft. with invert, or 1,011 cu.ft. without invert, the latter including 7.5 cu.ft. for center drain. Masonry for the arch and sides requires 160 cu.ft. per foot; if the invert is used, there is an additional 68 cu.ft. and 8 cu.ft. for the center drain built upon it. Rubble stone filling on the invert, up to subgrade, amounts to 45 cu.ft. per foot.

Electrification—The railway is operated by steam locomotives, but electric traction is used for the suburban service on the four-track line from Bombay to Kalyan, 30 miles. Early in 1927 a contract was let for main-line electrification from Kalyan east to Igatpuri, 45 miles, and from Kalyan southeast to Poona, 85 miles, a total of 160 miles of double-track lines carrying heavy traffic. The decision in favor of this electric project a few years ago was an important factor in pushing forward the project for straightening the line, although the estimates showed that this work would be justified even with steam operation. A transmission line will deliver 120,000-volt alternate current to substations which will transform it to 1,500-volt direct current for the overhead line with catenary cable support. Passenger locomotives will be of the 4:6:2 type, with six motors of 300 hp. Freight locomotives will have two six-wheel driving trucks, with a 1,500-hp. motor on each truck.

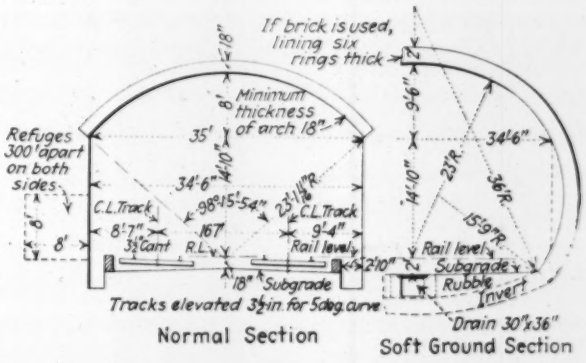


FIG. 3—TUNNEL SECTIONS

Construction Work—Much of the grading on the cutoff is in rock and firm ground, the cuts standing at steep slopes and having a depth of about 60 ft. at the tunnel portals. Width of subgrade is 35½ ft. on fills and 43½ ft. over side drains in cuts, with tracks spaced 15½ ft. c. to c. These widths are increased 1 ft. on the 5-deg. curves, where the track spacing is 16 ft. 7 in. Although the fills are not high, they are on steep sidehill slopes, so that at many points masonry toe walls are required to maintain sufficient width at subgrade. There are six minor steel bridges, but numerous culverts and small waterway openings are required. In this rocky region, with mountains mainly of trap rock, there is little trouble from slides. As the rainfall amounts usually to 200 in. during the four months June to Septem-

ber, inclusive, all outdoor construction work is at a standstill during this rainy season, but work continues on the tunnels. During the remaining eight months there is practically no rain.

Work was commenced May 1, 1926, and is to be completed by June, 1928. The Tata Construction Co., Bombay, has the contract, and J. Pollak is its chief agent in charge. This improvement was planned originally under the direction of R. V. Symon, then chief engineer of the Great Indian Peninsula Ry.; C. Tedman is now acting chief engineer, and W. H. Hogarth is engineer in charge of construction.

New State Technological College at Lubbock, Tex.

School Is a Feature of Industrial Development in the Great Plains District—General Layout—Buildings and Staff

WITH the rapid settlement and development of the great northwestern section of Texas during the past few years, there came a desire for a local institution devoted to technical and industrial education, particularly in the lines of engineering and of manufacture from the various raw materials produced within the state. In 1923, therefore, the Texas legislature passed a bill establishing the Texas Technological College, to be located west of the 98th meridian and north of the 29th parallel. The city of Lubbock secured the location of this institution and aided in obtaining land for the site adjacent to the city. This city, of about 15,000 population, is a railway and highway center, situated at an elevation of 3,250 ft. above sea level.

This new institution was opened on October 1, 1925. In January, 1926, it had 1,015 students and by January, 1927, the number had increased to 1,374. Of the 863 male students, 364 (or 43 per cent) were enrolled in the school of engineering, which has standard four-year courses and offers the degree of bachelor in architecture and in civil, mechanical, electrical and textile engineering. This last branch is given special attention in view of the extent of the cotton-growing industry in Texas. There are four schools organized at the college at present: liberal arts, engineering, agriculture and home economics. Each of these is headed by a dean.

Two of the present structures, the Administration Building and Textile Engineering Building, are shown in Figs. 1 and 3. Including the campus and farms this institution has a property of about 2,000 acres. From the general plan, Fig. 2, as prepared by the architects,

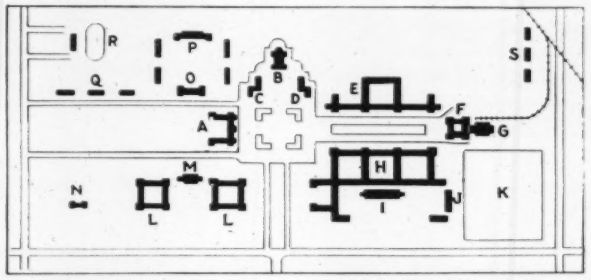


FIG. 2—LAYOUT OF TEXAS TECHNOLOGICAL COLLEGE

A, Administration Building and College Hall. B, Auditorium. C, Chemistry Building. D, Physics Building. E, Engineering group. F, Textile Building. G, Power house and heating plant. H, Men's halls. I, Men's dining hall. J, Gymnasium. K, Drill ground. L, Women's hall. M, Women's dining hall. N, President's residence. O, Library. P, Agricultural school buildings. Q, Buildings for Y.M.C.A., etc. R, Athletic field. S, Barns.

it will be seen that there is to be a group of engineering buildings. As the main Engineering Hall has not yet been erected, all engineering courses are handled at present in the Textile Engineering Building, which will form a part of the future group and will be used eventually for the textile department exclusively. Existing buildings, some of which are of temporary construction, include (1) Administration building; (2) textile engineering; (3) temporary engineering shop; (4) home economics; (5) temporary power station and heating plant; (6) temporary gymnasium; (7) agricultural barns; (8) stock judging pavilion; (9) cafeteria; and (10) president's residence. Future additions will include: (11) engineering hall; (12) chemistry building, and (13) two wings for the administration building, which will make it a U-shaped structure.

The textile engineering building as now constructed, Figs. 3 and 4, is approximately 218x60 ft., with 27,000 sq.ft. of floor area. It forms one side of a future hollow square, a driveway through the first floor giving

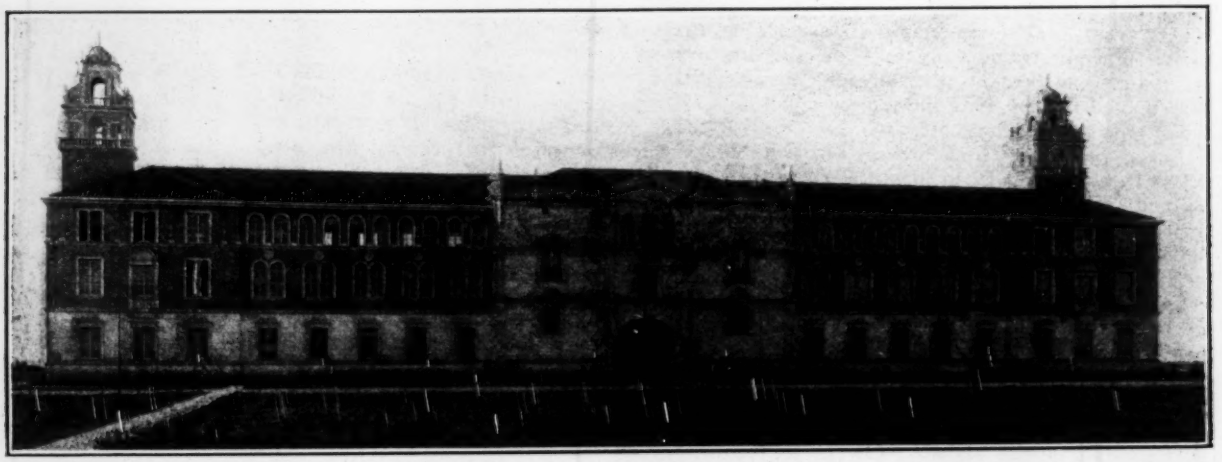


FIG. 1—ADMINISTRATION BUILDING: TEXAS TECHNOLOGICAL COLLEGE, LUBBOCK, TEX.

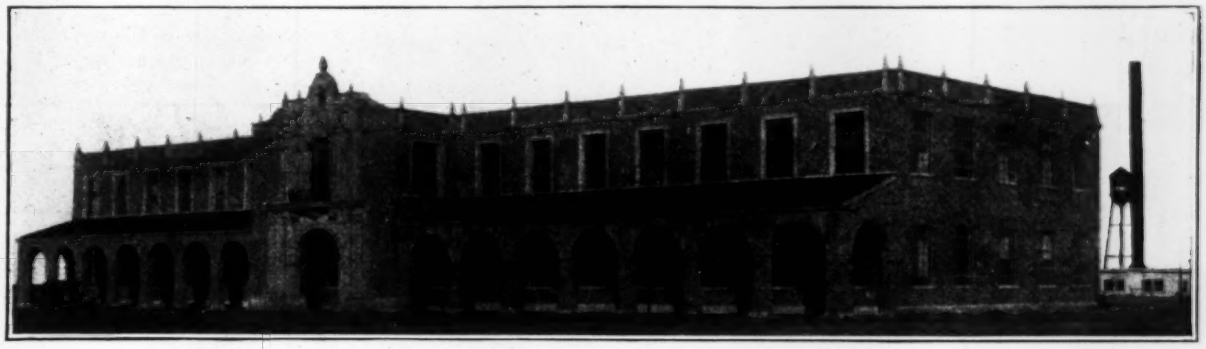


FIG. 3—TEXTILE ENGINEERING BUILDING, TEXAS TECHNOLOGICAL COLLEGE

access to the enclosed court. As at present arranged, see Fig. 4, it provides four large textile laboratories, five class rooms, a large display room and two offices. This interior arrangement will be changed later, when the building is enlarged and other structures are erected to accommodate some of the work now concentrated here. Adjacent to it is a temporary building, 50x100 ft.,

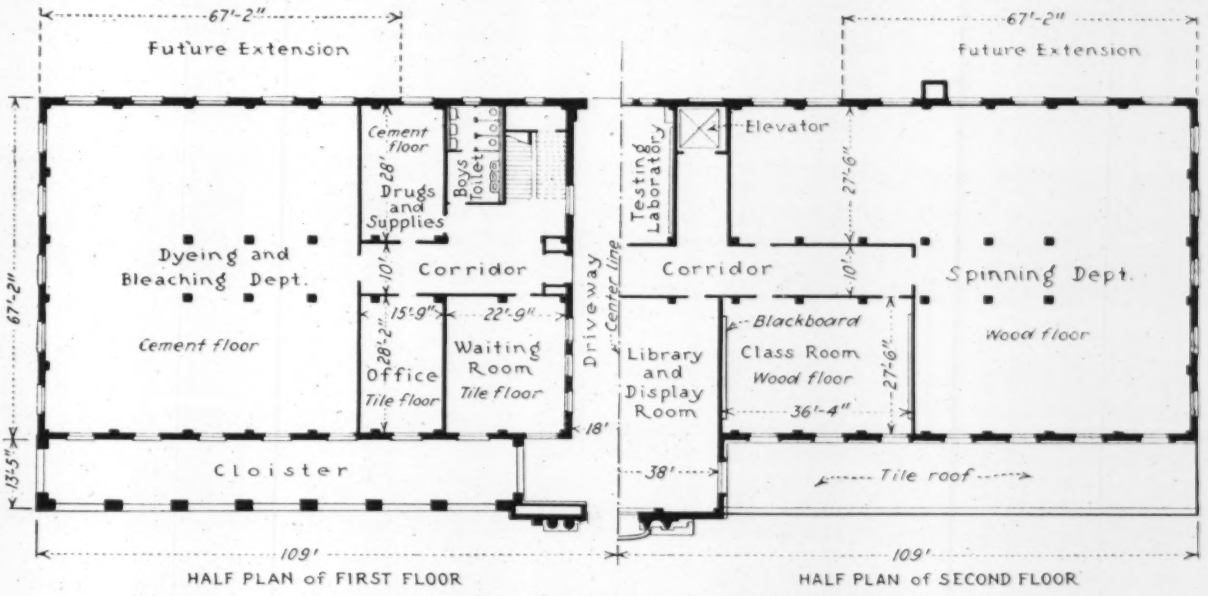


FIG. 4—FLOOR PLAN OF TEXTILE ENGINEERING BUILDING

of hollow tile and timber construction, housing the machine shop, pattern-making shop and an elementary mechanical engineering laboratory. About $75,000 has been spent for complete textile engineering equipment and $30,000 for elementary equipment for the other engineering departments, while $150,000 is required to complete this latter equipment.

All the permanent buildings, two and three stories high, have reinforced-concrete framing, with floors of the beam and girder type, designed for 70-lb. live-load. Brick and hollow tile are used for the walls and partitions. Arched cloisters extend along the front. In the general architectural treatment the exterior walls are of buff brick and gray stucco, with limestone trimmings and red tile roofs.

The associated architects were Sanguinet, Staats & Hedrick (firm name now Wyatt C. Hedrick), of Fort Worth, Tex., and William Ward Watkin, of Houston, Tex., with L. W. Robert & Co., Atlanta, Ga., as consulting engineers. The Textile Engineering Building was built by James T. Taylor, Fort Worth; the Administration Building by Ramey Brothers, El Paso; and the Woman's Building and president's residence by J. B. Maxey, Lubbock, Tex.

Paul W. Horn is president of the Texas Technological College. William J. Miller is dean of engineering and professor of electrical engineering; Edmond W. Camp, professor of textile engineering; Carl L. Svensen, professor of enginering drawing; James H. Murdough, associate professor of civil engineering; George L. Tuve, associate professor of mechanical engineering, and Edgar G. Shelton, associate professor of architecture.

Record Day's Rainfall in Panama

On May 20, 1927, 12.42 in. of rain fell in the San Blas region of Panama, according to a report from the station at Nicuesa to the Panama Section of Surveys. The previous high record was 12.25 in. on Oct. 23, 1923. Rain fell every day during the month of May, except two. The total for the month was 56.33 in. This has been exceeded only once on the Isthmus since rainfall records were kept, in December, 1909, when 58.17 in. fell at Porto Bello.

A Series of Eight Articles on

Winter Construction Methods and Plant

BY C. S. HILL
Associate Editor, Engineering News-Record

1. Planning and Servicing Winter Construction
2. Winter Care and Servicing of Equipment
3. Winter Excavation and Embankment Construction
4. Concrete Road Construction in Winter
5. *Winter Heating Concrete Materials and Mix*
6. Handling and Placing Concrete in Winter
7. Protecting Winter Placed Concrete
8. Winter Inclosure in Building Construction

5. Winter Heating of Concrete Materials and Mix

COLD has a positive effect on concrete. It retards or can absolutely check setting and hardening. Concrete is again exceptional among major construction materials in the property that setting and hardening develop heat which in a measure resists frost action. The reactions between cold and heat generated in setting and hardening range between wide limits. Concrete construction is, therefore, the major problem of the winter builder; it offers his chief hazard, and demands his best technical skill. If knowledge and skill are rigidly applied, concrete construction can be carried on at extremely low temperatures with full confidence of good results. There can be no lack or neglect, however, without extreme hazard.

Importance of Temperature—Heat is requisite for the setting and hardening of concrete and in hardening concrete develops heat. Heat conservation to the extent necessary for continued setting and hardening until strength is attained to carry at least construction loads is, then, the essential task of winter concreting. With standard portland cement, test and experience indicate that the temperature should be kept at not less than 50 to 60 deg. for five days. This assertion is made despite the fact that construction records present many examples of structures which have set up and hardened and are apparently structurally sound, in which the curing temperatures did not exceed 40 to 50 deg. The five-day period gives concrete a strength at which heating, or protection from cold, can ordinarily, in construction, be discontinued. At low temperatures, concrete thereafter does not continue to gain strength in a normal manner—it cures and hardens and becomes strong slowly. There must, therefore, in winter be especial care in removing forms and in reposting floor slabs and beams. Cold weather, then, as it has to be regarded in concrete construction, is not confined to actual frost, but to any degree of cold less, say, than 50 deg.

Special Mixes—To hasten the gain in strength and therefore reduce the period for which concrete must be kept warm and given particular care, special concrete mixes are available and to some extent have been used. The chief of these are (1) high alumina cement mixes, (2) high early-strength mixes of standard portland cement, and (3) accelerating admixtures themselves resistant to freezing. Experience indicates beyond question that for winter work all concrete should be as dry as it can be readily worked. Quicker hardening is thus assured, and in addition the water film and laitance particularly susceptible to freezing are reduced.

Alumina Cement—High alumina cements set and harden much more rapidly than does standard portland cement and there is a correspondingly intensified heat development. Broadly, concretes of special alumina cements have a strength in 24 hours equal to the strength of ordinary portland cement concrete in 28 days. As indicating the quick rise in temperature, a graph, one from tests made at the University of Minnesota, is given in Fig. 15. The early strength reduces the period during which the concrete has to be kept warm and the high heat development increases the counteraction against frost. In using alumina cement concretes, and particularly in their curing, variations from practices with portland cement are required; the user has to bear this fact very firmly in mind when resort is made to alumina cement concretes. The use of alumina cement specifically for cold weather construction has been rather tentative. Some examples were given in Article 4. In general, it may be concluded:

1. As alumina cement concrete gains strength and generates heat more quickly than does standard portland cement concrete, it decreases the time for which it is necessary to keep the concrete in place warm.

2. Users need to become familiar with the characteristicts in setting and curing when they undertake the use of high alumina cement concrete.

The special high-grade portland cements, some of which are made in Germany, developing in two days the strength at 7 to 28 days of normal portland fall in the same category as high alumina cements.

Early Strength Mixes—By special proportioning and mixing, a concrete can be made of standard portland cement which in 3 days has the strength of normal mixes

at 28 days. The processes are: decrease the water; increase the mixing time; increase the cement; add calcium chloride; keep the placed concrete damp and warm (70 deg.). A care in production is involved in these processes which ordinary field control of concrete has not practiced. With this care, high early strength concrete is practicable with any reasonably well-equipped mixing crew. These high early strength portland cement concretes must be kept warm until strength is acquired; their activity compared with standard mixes merely cuts down the period of necessary protection. There has been no extensive use of high early strength concrete specifically for cold weather construction.

Mixes with Admixtures—Admixtures have an older standing as aids in cold weather concreting than have special concretes or special mixes. In using admixtures, two requirements have to be adhered to: (1) the substance must lower the freezing point of the mixing water and (2) it must accelerate the setting and hardening of the concrete. Of the various available substances which meet both requirements, calcium chloride is the most practicable because of its general availability and the familiarity of the workmen with it. The amounts of calcium chloride which may be used with advantage vary with the chlorine content and with the brand of cement; it is wise practice, therefore, to make up trial batches under the conditions and note the rate of hardening and the effect on strength. In general, 2 to 4 per cent of

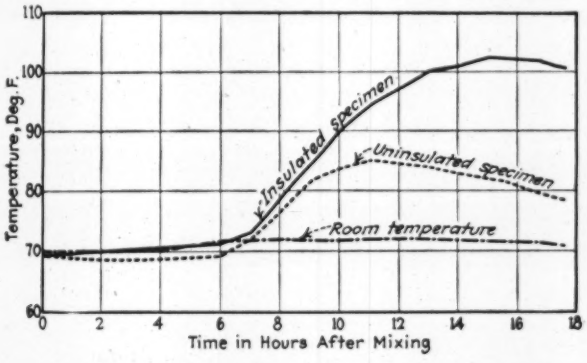


FIG. 15—RISE IN TEMPERATURE DURING SETTING PERIOD OF ALUMINA CEMENT CONCRETE

the weight of the cement is about the safe percentage; more is likely to decrease the strength. A solution and not dry powder should be used; about 4½ pints of saturated solution per sack of cement is equivalent to 3 per cent of the cement by weight. With considerable experimentation and experience to reason from, the conclusions of several investigators are:

1. Dependence should not be placed on the lowered freezing point of the mixing water.

2. In cold weather it is much wiser to heat the concrete, furnish proper protection and supply artificial heat, than to depend on an admixture.

Heated Concrete—The most common way of producing heated concrete is to preheat the materials. On occasion, heating in the mixer is undertaken, but most often mixer heating is supplementary to preheating the aggregates and water. The use of preheated materials predicates that the mixing operation proper shall preferably be protected from the cold. The consideration of heating concrete materials, then, will include housing the mixers and the proportioning and charging space, and often the mixer discharging space.

In the matter of heating materials, practice presents two schools of thinking. With one, no more heating is undertaken of the sand and of the coarse aggregate than is necessary to remove the frost and prevent congealed masses or lumps from going into the mixer. These materials, it is held, are so hard to heat and hold their heat so poorly, that it is economy to put the heat into the water and depend on it to make the mix warm. The second school holds that the aggregates as well as the water should be given a temperature. It is argued that

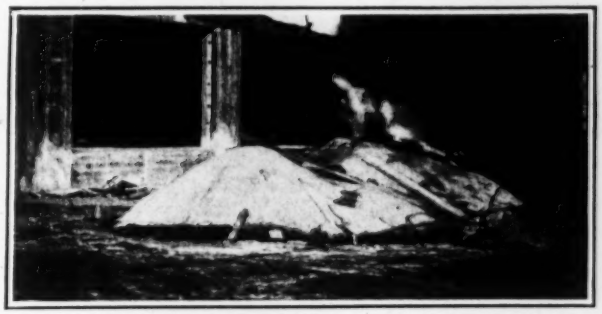


FIG. 16—TARPAULIN COVER ON STEAM-JET-HEATED STOCK PILE

the water alone, perhaps no more than 20 per cent of the volume, cannot carry enough heat to warm the mix adequately for really cold weather operations. A decision between the two will depend probably on related conditions of mass, exposure, temperature, and structural hazard. The objective is to get concrete into the forms and there hold it at a temperature which will keep it active until it has enough strength to eliminate the frost hazard. Records from practice of concrete temperatures at the mixer range from 40 deg. to 125 deg. Ordinarily, a temperature of 80 to 90 deg. is necessary at the mixer to ensure a temperature of 60 to 70 deg. in the forms. This subject is considered further in Article 6.

Heating Open Stock Piles—Open stock pile heating is employed chiefly where the mixer is charged by barrows or hand carts. The common heating devices are: (1) furnaces over which the sand and coarse aggregate are shoveled for heating; (2) steam jets inserted in the stock piles; and (3) steam pipe grills over which the materials are stocked. In rare instances rotary driers have been employed. For considerable outputs these devices have to be faster than for ordinary drying purposes and of large size which makes the investment large. Their output too must be used as produced, continuously; they provide no storage of heated stock. As yet mechanical heaters have not been developed to command attention by concrete builders.

Furnaces generally speaking are limited to small operations. Ordinarily they are of job production; an iron pipe with an improvised chimney at one end and wood fires inside is common construction. Several units can be fitted out according to the size of the operation. In isolated operations a masonry furnace is practicable. On dam construction in Colorado (Lake Humphreys, Carl A. Gould, Denver, engineer) an open-top masonry furnace 10 ft. wide, 20 ft. long and 30 in. high was constructed with I-beams across the top, 400 ft. of 1-in. pipe grill on these and $\frac{5}{16}$-in. boiler plate on the grill. A wood fire was kept going in the furnace, the water was passed through the pipe grill and the aggregates were spread on the sheet-iron top. The mixer, 9 cu.ft., was charged

with wheelbarrows and turned out concrete at 80 deg. Job conditions and available material will suggest other forms of improvised furnaces. With furnace heating two conditions have to be observed:

1. Constant replacement, piling cold material on and removing warm material, and

2. Careful watching to make sure that the aggregate particles are not injured by overheating.

Heating with steam jets serves a wider range of demands than does furnace heating. Overheating is not possible and no shifting of stock is required; instead the steam jets are shifted. A good form of jet is a 1 to 1½-in. pipe 6 ft. long drawn to a closed point at one end and fitted for hose connection at the other end. Staggered perforations, $\frac{3}{16}$ to ¼-in. holes, should be provided 1½ ft. apart. A hose connects the jet pipe with the steam line. The jets are pushed into the piles when and where needed, and steam is turned on as long as it is required. When taking from stock a good arrangement

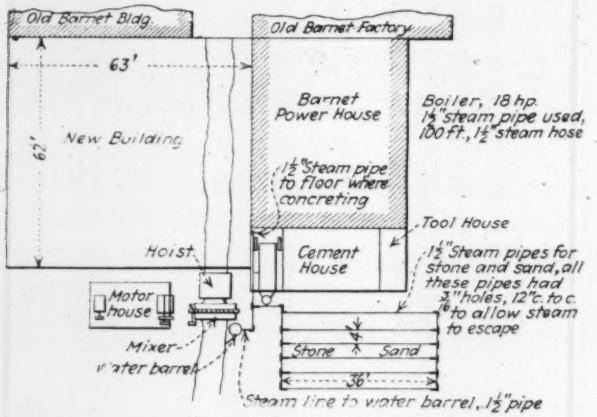

Old Barnet Bldg.
Old Barnet Factory
63'
62'
New Building
Barnet Power House
Boiler, 18 hp. 1¼" steam pipe used, 100 ft., 1½" steam hose
1½" Steam pipe to floor where concreting
Tool House
Hoist
Cement House
1½" Steam pipes for stone and sand, all these pipes had ⅜" holes, 12" c. to c. to allow steam to escape
Motor house
Mixer
Stone
Sand
36'
Steam line to water barrel, 1½" pipe

FIG. 17—STEAM GRILL ARRANGEMENT FOR HEATING AGGREGATE STOCKPILE

is two jets in the stone pile and one jet in the sand pile just where the material is being taken away. For thawing and general heating, the jets are placed, kept in place, and shifted as required. In all steam jet heating, effectiveness is gained by covering the stock piles with tarpaulins which can be pulled aside for restocking. Fig. 16 shows tarpaulin-covered stock piles heated by steam jets.

Pipe grills are more elaborate heating units for larger storage than is considered for furnace or steam jet heating. In general, they are laid out on the ground or on planking to cover an area slightly smaller than the base of the stock pile. A rectangular grid form is most common. Fig. 17 is an example (Turner Construction Co., New York). The practice for a large operation of this company runs about as follows: A 50-hp. boiler carrying from 50 to 60 lb. of steam is necessary; on smaller operations like that shown in Fig. 17 an 18- to 25-hp. unit will serve at 35 lb. Generally, on any considerable building, a boiler of less than 50 hp. has to be pushed hard to heat stock piles and water and to give steam to floor lines for cleaning and heating forms. For heating aggregates, the grill is made up of 1½-in. pipes spread 4 ft. apart and perforated with ⅜- to ¼-in. holes staggered every 18 in. In places where sand clogs the holes, hacksaw slots have met the difficulty. It is required that sand and stone have a temperature of 35 to 50 deg. and water a temperature of 100 to 150 deg., and the heating units are made large enough to get these temperatures with the outputs planned.

Lack of capacity is the prevailing error in heating with grills; grill area and steam pressure are made too small and the time allowed for heating is too short. In general:

1. Spread the material over the grill uniformly a few feet deep; do not heap it in a cone-shaped pile.

2. Cover the pile with tarpaulin at night, and at whatever other times it is practicable.

3. Provide enough boiler pressure and capacity con-

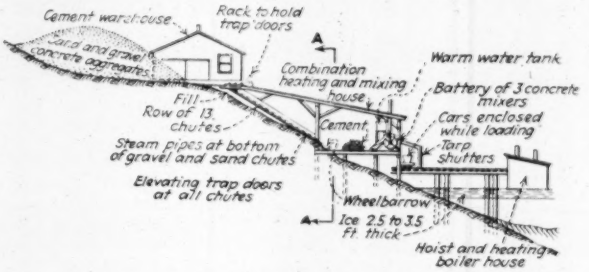


FIG. 18—ARRANGEMENT FOR HEATING AGGREGATES IN CHUTES

tinuously to give good strong jets from the pipe perforations.

4. Allow 24 hours for heating each day's draw-off of material for concrete.

Heating in Open Bins—Open-top bin heating is virtually an application of the steam grill system; the grill is laid on the sides and bottoms of the bins. Being confined and insulated by the bin walls, the utilization of the heat is more complete than in open stock piles. Otherwise, the requirements for grill heating in stock piles apply to grill heating in bins, even to the tarpaulin covering at practicable times. Examples give best prevailing practice in open bin heating.

A diagram of a heating plant notable for its full housing employed on bridge pier construction in Alberta, Canada, is given by Fig. 18. The aggregate heating unit consisted of eleven parallel chutes which were filled and emptied in rotation. Each chute was 3 ft. wide, 16 in. deep, and 24 ft. long, and had in the bottom a close grid of 1¼-in. steam pipes provided with valves for heat regulation. The chutes were filled at the top by shoveling from stockpile and emptied at the bottom by gating into wheelbarrows. A chuteful was heated in about half an hour. A 12-hp. boiler and exhaust from

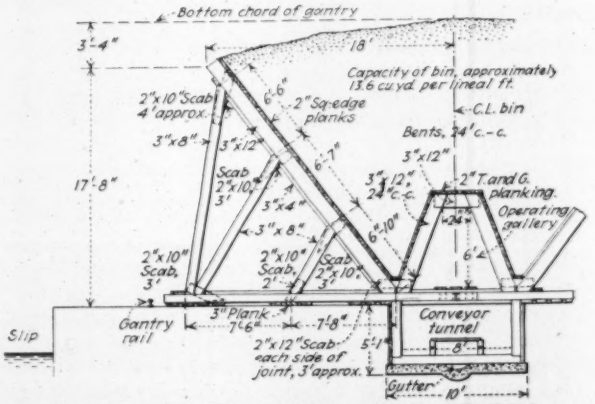


FIG. 19—GRILL-LINED OPEN BIN FOR HEATING AGGREGATES

the mixers supplied the heat. The complete housing of all operations is indicated. The temperature of each batch as it left the mixers (two 1-cu.yd. machines) was

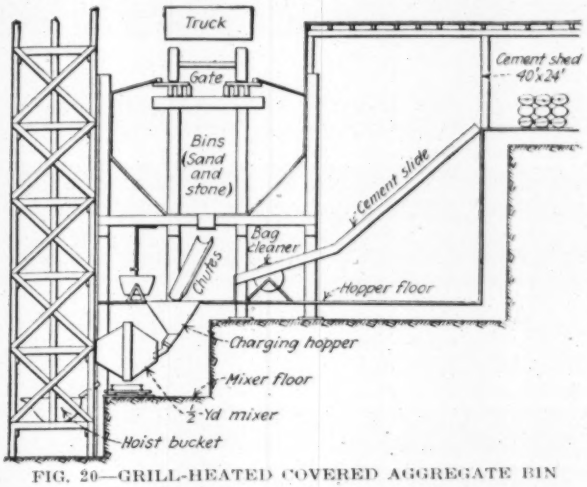


FIG. 20—GRILL-HEATED COVERED AGGREGATE BIN

tested by bath thermometers; this was done largely to keep a check on the heating. The construction was by force account. (Grand Trunk Pacific Ry., A. M. Bouillon, engineer in charge.)

At the New York Edison 14th St. power plant in New York City the aggregate bins shown by Fig. 19 were heated by rows of perforated ¾-in. steam pipe, some 5,100 ft., running lengthwise on all inside walls of the *W*. A 125-hp. boiler furnished steam. A similar heating arrangement was used in the mixer charging bins. (Kenn-Well Contracting Co., New York.)

In these two examples are shown the extremes in practice: (1) rapid heating in small volumes, virtually continuous heating, and (2) slow heating in large volumes, several days being required for material to pass through the bins.

Heating in Housed Bins—Heating in housed bins is a steam-grill process exactly similar to that in open-top bins except that (1) the tops of the bins are partly or temporarily roofed in, or (2) the bin structure is completely inclosed in a housing.

An example of partly roofed bin is given in Fig. 20. This arrangement was employed in building construction. The grill on sides and slopes was perforated pipe; a 35-hp. boiler furnished steam. It was found possible to give the materials 150 deg. temperature. (Lundorf-Bicknell Co., Cleveland.) Often the arrangement is the more simple one of a tarpaulin covering spread over the bin top at night and at such times during the day as bin filling leaves any considerable available time.

A notable example of complete enclosure is furnished by the Gulf Island dam on the Androscoggin River in Maine, 1925-6, where about 30,000 cu.yd. of concrete were placed during two winters, the greater bulk at temperatures below freezing. Screened and washed sand and gravel were brought in by hopper cars to stock piles or directly into the aggregate house shown by Fig. 21. The house completely inclosed the bins, even to doors at the entrance end. From it, the incline to the mixer house was inclosed, and so was the belt conveyor to the charging floor from the cement house. In brief, every operation of bin storage and concrete proportioning and mixing was housed, and the buildings were steam heated; there was not one unsheltered operation or one without comfortable warmth. The bins held 300 carloads, and there was space on the tracks for six loaded cars. On the bin bottoms there were two steam pipes, and also on the posts in the bins three tiers, five pipes high. With doors closed, the bins were kept at 60 deg. A 9,000-gal. tank with a steam coil in the bottom heated the water to 100 deg. The concrete left the mixers at 80 to 90 deg. temperature. (Morton C. Tuttle Co., Boston.)

A heating shed for thawing and warming materials in cars is shown by Fig. 22. This structure was used on building work near Chicago (Thompson-Starrett Co., Chicago). The entrance end was closed with curtains of canvas and when shut tight for the night the inside temperature ran up to 100 deg. at —10 deg. outside. The shed held twelve cars.

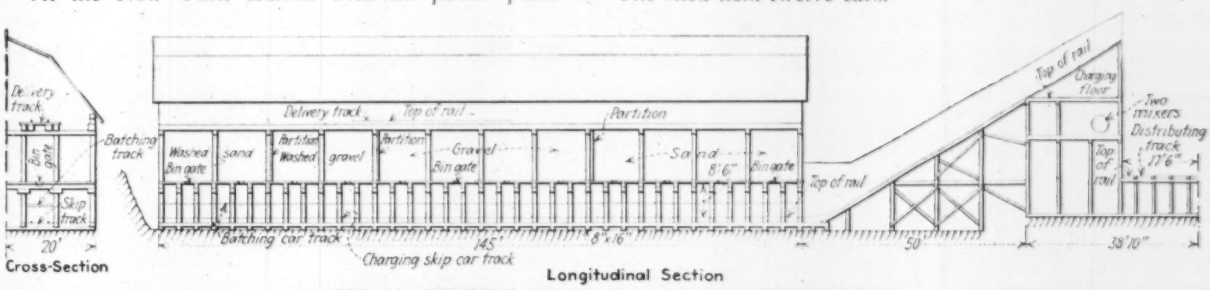


FIG. 21—HEATING HOUSE FOR AGGREGATE IN BINS

Aggregate Temperatures—The temperature to which aggregates are heated, where actual heating and not merely thawing is undertaken, in practice varies from 40 deg. to claimed temperatures exceeding 100 deg.

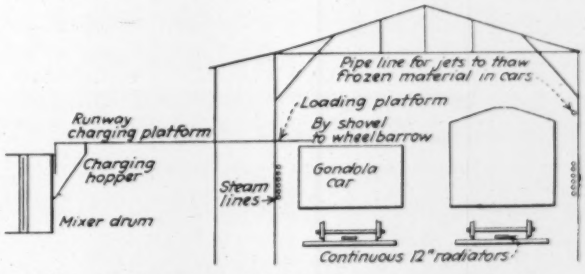


FIG. 22—HEATING HOUSE FOR AGGREGATE IN RAILWAY CARS

Sand, gravel and broken stone have low specific heat and they lose temperature rapidly in handling. It is not common, perhaps, with ordinary practices, that aggregate can be got into the mixer at upward of 50-60 deg. heat.

Flame Heating in Mixer—Heating in the mixer ordinarily may be considered as supplementary to preheating

the materials, its function being to repair loss of temperature in charging and mixing and to give, perhaps, a few degrees added temperature. For the ordinary mixing period, the gain in temperature cannot be large. In about a score of runs made by the Pennsylvania highway department using flame injection, the results in Table II were obtained. For ordinary mixing periods, a temperature increase of about 10 deg. was recorded. On building work in New York City in 1926-7, with water heated and aggregates at outdoor temperatures, a flame heater for the regular mixing period of 55 sec. increased the temperature of the concrete about 10 deg. (Tucker Construction Co., Inc., New York.)

TABLE II—TEMPERATURES GAINED BY FLAME INJECTION INTO MIXER

Run No.	Concrete (Deg. F.)	Min. in Mixer	Run No.	Concrete (Deg. F.)	Min. in Mixer
	First Series			*Second Series Continued*	
1	55	1¼	2	60	1¼
2	56	1½	3	59	1¼
3	59	2	4	58	1¼
4	62	3	5	62	2
5	65	4	6	63	2
6	70	5	7	65	3
7	75	7	8	66	3
	Second Series		9	72	5
1	59	1¼	10	71	5

In the first series the original temperatures were: Air, 45-46 deg.; water, 49 deg.; aggregate, 40 deg.; and cement, 45 deg. In the second series, they were: Air, 43 deg.; water, 48 deg.; aggregate, 42 deg., and cement, 47 deg.

A ¾-cu.yd. mixer used on the Spier Falls power plant was fitted with two kerosene torches placed side by side in the charging opening. The mixer rotated at 17 r.p.m. A 20-gal. supply tank fed the torches which consumed about 3 gal. each per hour. Air pressure on the torches was irregular, varying from 30 to 75 lb., causing trouble by putting out the flames. Wind at times also extinguished the torches. The best pressure was 30 lb., and it was important that it be constant. Lighting by hand was dangerous; a gas range igniter attached to an acetylene gas tank was kept for lighting. Sand, cement and water were put into the mixer and turned a few times, and then stone was added. The torches were then turned on full for 1½ to 2½ minutes; this generally gave a mix temperature of 70 to 80 deg. Each additional half minute it was found raised the temperature about 22 deg. (C. Voetsch, engineer). Torches specially designed for mixer heating are on the market, and have been rather extensively used for small mixers.

Heating Mixing Water—For the ordinary operation, live steam injection into the water tank is about the simplest and most effective method of heating mixing water. A 1- to 1½-in. pipe, turned down into the tank to within a few inches of the bottom and provided with a valve at the hand of the mixer operator, is the usual device. For large tanks, 5,000 to 10,000 gal. supplies as in the case of heavy dam construction, a steam coil in the tank is preferable to the steam jet. This was the arrangement on the Gulf Island dam (Morton C. Tuttle Co., Boston), where there was a 9,000-gal. tank, and an average of 350 cu.yd. of concrete every working day was placed during the coldest weather. On powerhouse foundation construction (Kenn-Well Contracting Co., New York) a water-tube hot-water service heater rated to heat 4,300 gal. an hour from 50 deg. to 170 deg., with 80-lb. steam, was installed at the mixing plant. This gave hot water both for mixing and for washing out chute lines. In general, a modification of one of the three types of heating devices described is practicable on any winter concreting operation. Water may be heated to any temperature up to boiling if it is desired. The concrete will not take harm from boiling water. At the Castleton bridge (New York Central R.R., W. F. Jordan, engineer) boiling water was used and the concrete left the mixer at 125 deg. Ordinarily, the temperatures used range from 100 deg. to 150 deg. This heat is easily practicable by the methods described in actual work. The water has to be hot if the concrete is to be hot. Aggregate generally does not get into the mixer often at exceeding 50 deg. According to observations (Turner Construction Co., New York) it takes 6 deg. water temperature to raise 1 deg. the temperature of the other concrete ingredients, so if their temperature is 50 deg. and the water is 150 deg. the resulting concrete will not be over 67 deg.

Stone Preservation: English Research

STUDIES of the decay of building stones and possible methods of protection or preservation have been under way for nearly five years in England by a committee of the Department of Scientific and Industrial Research headed by Sir Aston Webb.

Two lines of investigation have been followed, a study of the physical and chemical phases of stone deterioration on the one hand, and investigation of possible biological (bacterial) actions on the other. The latter studies have shown that sound stone may contain many bacteria, even in the quarry and at a depth of 2 ft. back of the quarry face. Only 12 species of bacteria have been observed so far. One specimen of weathered stone produced bacterial colonies all of one kind, and it is intended to make further investigations to determine whether this kind has a specific relation to damage to the stone and whether there is a special stone flora.

The chemical and physical investigation is of two kinds, a general study of chemical and physical conditions in stone, mainly by study of microsections; and a series of tests of stone preservatives by applying them to a number of small piers, built of six different varieties of building stone, exposed on the roof of a building in London. The principal preservatives used in the pier tests are paraffin wax dissolved in ligroin, sodium silicate, barium monoxide followed by alum, barium monoxide followed by arsenic acid, silicon ester, and zinc magnesium silicofluoride. The piers were set up and treated in the summer of 1926, but there are no results as yet.

The investigation of physical and chemical features of new and weathered building stone is being carried out by Scott Russell for the committee. A method was developed for cutting thin sections, the stone being first impregnated with synthetic resin (bakelite type). Marked differences in structure of different limestones have been noticed, especially in oolitic stone, in some of which the ooliths are porous while in others the units are solid and interpenetrate each other. Stone in atmospheric exposure has been found to be subject to quite different action where it is freely washed by rain than where it is protected from the rain, and the difference may extend for several inches into the interior. In the protected position a layer of soot cemented by gypsum forms on the surface, and extensive gypsum replacement has been found under this surface layer. No definite relation between gypsum growth and disintegration of the stone has been found as yet, however. Laboratory tests on preservatives have also been made, but with no very conclusive results.

Large Power House Foundation Built in Wet Ground

Spread Footings Placed After Blanketing Sand with Seal Layer of Concrete on Tamped Gravel To Control Flow of Water

IN constructing the foundation of the Richmond power station of the Philadelphia Electric Co., on the west bank of the Delaware in the northern part of Philadelphia (described in *Engineering News-Record* Sept. 16, 1926, p. 450), it was necessary to build spread footings in permeable strata of sand, clay and gravel containing water under a head. According to a description of the work recently presented by Frank N. Kneas, chief engineer for the architect, John T. Windrim, before the American Society of Civil Engineers, this condition was dealt with by excavating within a cofferdam and simultaneously pumping from sump pits to lower the groundwater level as much as possible; then placing a seal layer of concrete at foundation level before constructing the reinforced-concrete footings. It would have been difficult or impossible to deposit concrete directly on the fine-grained but porous soil with water flowing through and over it, because of the risk of washouts developing either in the soil or in the concrete. The flow of water was controlled by placing a layer of pebbles or large gravel 4 in. thick on the sand, and compacting it by tamping. This allowed the water to seep upward but prevented movement of the sand, which was held back by the gravel. On the gravel layer the sealing mat of concrete was placed, and this gave a good base for the men to work on in placing forms and reinforcement for footings.

As an additional precaution against settlement due to disturbance of the ground, the joint between concrete and ground was grouted after the footings had been built to obtain firm bearing. Vertical pipes had been built into the sealing mat, and grout was forced down through them into the gravel layer over the soil, pumping being stopped in that part of the foundation area.

Datum plugs were inserted in the sealing mat, so that a check on settlement could be obtained; vertical pipes set over the plugs gave access to them through the reinforced-concrete footings. Levels were taken on these plugs after all of the main footings were poured. In the steam-turbine foundations, the most heavily loaded part, the lower part of the subfoundation weighed more than the turbine itself, and it was found that this weight forced the sealing mat down hard on the soil, producing settlements of 1 to 3 in. The grouting was done after this part of the foundation had set; the subsequent pouring of the upper part of the subfoundation caused settlements of only $\frac{1}{32}$ to $\frac{5}{32}$ in., averaging about $\frac{1}{16}$ in. As the total weight of the concrete in the upper sub-foundation is five times the weight of the turbine, this result was assurance against settlement of the turbines.

Subsoil—Careful studies of subsoil were made before the general type of foundation for this power house was decided upon. The location is in marshy ground on the river bank, and the outer third of the power house as well as the coaling tower had to be built in open water outshore of the original riverbank dike. Rock was found to lie about 100 ft. below the surface. Except for a surface layer of muck and silt, the soil above rock consisted of alternating layers of sand, clay and gravel, the upper part of which represented glacial outwash deposits. The required depth of construction brought the foundation level partly into these glacial deposits and partly into the underlying Raritan formation, a marine deposit of white sand, gravel and clay. Soil samples from various depths were subjected to mechanical analysis, and a sheeted test pit 9 ft. square was dug, both to explore the soil and to give data on ground-water conditions. Constant pumping was required in excavating the pit, but it was found that this pumping slowly drained groundwater out of the sand and gravel strata below the surface muck, and had no connection with either the river water or the surface water of the marsh. The rate of water flow through the soil was calculated from the mechanical analyses, and was also determined by direct tests of flow through short lengths of pipe filled with the soil samples. From the resulting data it was possible to predict that the pumpage in the main cofferdam of the foundation would not exceed about 3,000 gal. per minute, and actual experience in construction later verified the prediction.

Load Tests—Soil load tests were made to show the relation between load and settlement. Four loading masts in the test pit, under a weight of 4¼ tons per sq.ft. indicated a probable settlement of less than ¼ in., but because of some irregularity another test was made with a bearing area of about 5 sq.ft., which showed a settlement of ⅛ in. under 4.4 tons per sq.ft. on first loading and only $\frac{1}{16}$ in. under 10 tons per sq.ft. on second loading after releasing the first load. This test loading was done on a bed of coarse sand and pebbles overlying finer, softer strata. But the intake and discharge tunnels, which were built as an integral part of a group of column and wall foundations, had to be carried down into the softer strata, and mainly for this reason a loading of 3 tons per square foot was decided upon, in order to have ample margin against any differences of settlement.

Method of Excavation—Excavation to foundation level was carried on in two sections. The inner part of the site was excavated behind the protection of the river bank dike serving as a cofferdam. Especially deep sections of foundation construction inside this area, as for the turbine foundations and adjacent parts of the intake and discharge tunnels, were excavated inside of steel sheetpile inclosures, which were left in place. To insulate the building foundations from the turbine foundations in the matter of vibration, the turbine foundation sheetpiling was lined with ¾-in. hair felt.

The part of the building outside the original riverbank dike was built by first constructing the outer walls of the boiler house within a double-wall steel sheetpile cofferdam, and then using the concrete wall, when completed, as cofferdam to protect excavation and foundation work inside. The coaling tower, some distance outstream from the boiler house, was located at a point where the coarse sand foundation stratum lay at a depth of 40 ft. below water; the footings at the four corners of the tower were designed as hollow concrete boxes, and each was built inside of an open cofferdam of braced sheetpiling. By pumping in one cofferdam and excavating in another it was possible to draw down the water in the strata below the river bottom sufficiently to enable the excavation to be carried down to the desired level and the footings to be constructed. The work was exceedingly difficult, but was successfully carried through without the use of compressed air.

The Economics of Concrete Mixes for Road Work

Strength Secured by Extra Thickness at Equal Cost Using 1:2 Mortar Ratio with Controlled Sand Bulking and Stone Voids

By R. T. Giles
Physical Testing Engineer, North Carolina State Highway Commission, Raleigh, N. C.

IT IS recognized by the writer that conditions, mixes and aggregates vary in different sections, and that results found to hold true in one section may vary in other sections. When, however, broken stone is used as coarse aggregate and sand as fine aggregate the conditions found in North Carolina should in a general way hold true in other sections.

Proceedings A.S.T.M., Vol. 24, Part II, 1924 (Jackson & Pauls), show that a 1 to 2 ratio between the cement and sand will give as satisfactory a concrete from the standpoint of wear as a richer mix. This has

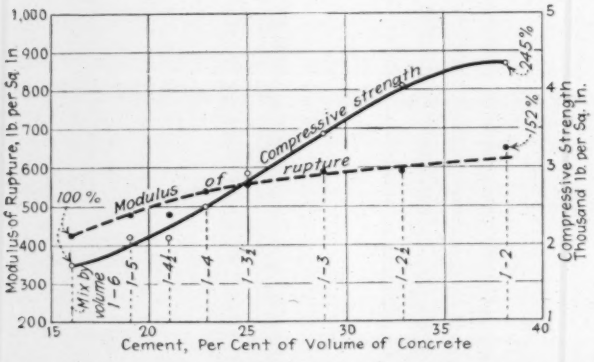


FIG. 1—EFFECT OF QUANTITY OF CEMENT ON STRENGTH AT 28 DAYS

Using 0 to 1½-in. sand-pebble aggregate; relative consistency, 1:10; age of test, 28 days.

also been found to hold true in road work in North Carolina. Observation also justifies the belief that the raveling of concrete at cracks is not helped by a richer mortar than a 1 to 2.

If these observations are facts, then it would seem practical and economical to secure the required strength of the slab by extra thickness and the extra thickness can in many cases be secured at no additional cost, provided the sand is proportioned accurately enough to be sure to get the full value of the 1:2 ratio and not a leaner mix. In other words, for every bag of cement 2 cu.ft. of sand, with no more or less, must be used. This has been a real problem in the past.

Bulking of Sand—Everyone knows that the measurement of damp sand will vary in volume up to 25 or 30 per cent. The use of a correction factor for the bulking of sand is an improvement, but at best is still hit or miss proportioning. The bulking factor, if the sample is taken from the top of the pile, is not correct for 2 or 6 ft. under the top, nor is the bulking factor, if the sample is taken from 2 ft. under the top, correct for the top or 6 ft. under the top.

As the use of a bulking factor is an improvement over normal volumetric proportion so is the use of a weighing device and, between the two, the weighing device is probably the better. In both cases the accuracy depends to a very large extent upon the inspector and the equipment with which he is working. To try to determine to what degree the weighing device would be accurate 24 samples of sand were taken from one pit and weights per cubic foot established on each after the samples had been dried. These weights varied from 95.5 lb. to 103.1 lb. Since cars of sand could be shipped from any location from which these samples were taken on the same day to the same job, it is apparent that an error of 7.2 per cent could, and most likely would, occur unless a sample were taken from each batch, and the weight per cubic foot established for that particular batch. This is of course impracticable. In addition to 7.2 per cent of error likely from the change of the weights per cubic foot of the sand, it is entirely possible and more than likely probable that an error of as much as 3 per cent will develop from the moisture in the sand. This would make a total error of 10.2 per cent.

The most accurate method of proportioning sand is to have the sand bone dry and to measure it volumetrically. Tests using dry sand were run to determine the per cent of compaction possible by dropping the sand from various heights. It was found that dry sand would compact 0.1 per cent for each foot of drop, or 1 per cent for a 10-ft. drop.

The only method by which this accuracy could be approached was the inundation method. From the tests run it is believed that the maximum error by this method is 3 per cent. Since this method seems to be the most accurate, when the economy and job conditions are taken into consideration, it has been used in computing the costs of the concrete in this article.

Voids Control of Stone—The measurement of the coarse aggregate is comparatively an easy problem. The control of the voids in the coarse aggregate is probably a bigger problem than the control of the sand and is of equal importance. The variation in the voids is caused principally by segregation in the stock piles and bins. With a stone graded from ¼ to 2½ in. the voids will vary from less than 40 per cent to over 48 per cent, with an average on jobs of 45 per cent. It is entirely possible, and can be made practicable, to proportion the coarse aggregate in three different sizes so that the voids can be kept constant and at a minimum.

Cost of Extra Thickness—Accepting these conditions as general and the remedies as sound, it can be seen from

TABLE I—COST OF EXTRA SLAB THICKNESS WITH DIFFERENT MIXES

(Volumetric measure. Sand measured in bulked condition. Stone taken from stock pile. Actual sand in mix = ⅘ specified volume.)

Mix No.	Proportions	Cost per Cu.Ft. of Concrete	Using 4-bag batch: Sand Used	Voids in Stone Cu.Ft.	Per Cent Voids
1	1:1½:3	$0.342	5.25	5.4	45
2	1:2 :4	.29	7.00	7.2	45
Inundated sand and stone from stock pile:					
3	1:2:4½	.27	8.00	8.1	45
Inundated sand and voids in stone controlled:					
4	1:2:5	.255	8.00	8.0	40

Comparative Costs

Pavement thickness, in.		Material Cost, Sq.Yd.						
Mix No.		6	6½	6¾	7	7¼	7½	8
1		$1.539	$1.624	$1.71	$1.796	$1.881	$1.967	$2.053
2		1.305	1.377	1.45	1.522	1.595	1.667	1.74
3		1.215	1.282	1.35	1.417	1.485	1.552	1.62
4		1.147	1.211	1.275	1.338	1.402	1.466	1.53

Table I to what extent the cost of roadway concrete can be reduced in price or the life of the roadway prolonged by extra thickness at the same cost. In working up these figures the following prices were used: Cement $2.80 per barrel; sand $2 per cubic yard, and stone $3 per cubic yard, all prices on siding at job. These prices will vary under different conditions and will affect jobs in different ratios. A contractor has supplied the information that, with an average haul of four miles, for the increase of the thickness of road of each one-third of an inch the unloading and haulage charge would be increased 4c. per square yard.

On any job, where the conditions were comparable with the ones given here, a 6-in. slab of mix No. 1 would cost as much as a 7-in. slab of mix No. 4 and still leave $0.081 per square yard for proportioning the coarse aggregate to reduce the voids to 40 per cent and inundating the sand. The question then would be whether the 7-in. slab with an accurately controlled concrete of a 1:2:5 mix is as good as a 6-in. slab of inaccurately controlled concrete of a 1:1½:3 mix.

Relative Slab Strengths—The relative resistance to impact of slabs as reported by the Bureau of Public Roads (*Public Roads*, April, 1924), is as follows for dry subgrades, the load applied at the edge:

Mix	Slab Thickness	Relative Value
1:1½:3	6	100.0
1: 3:6	6	91.5
1:1½:3	8	207.0
1:1½:3	4	66.5

It will be seen from the foregoing table that the thickness of the slab is the controlling factor rather than the richness of the mix, when the resistance to impact is considered. Assuming a relative value of 95 for a slab of a 1:2:5 mix, 6 in. thick, increasing the slab thickness from 6 to 7 in. would give an increase in slab value of 125 for a slab of a 1:2:5 mix, 7 in. thick, as compared to a relative value of 100 for a slab of 1:1½:3 mix, 6 in. thick.

An investigation by the Pennsylvania state highway

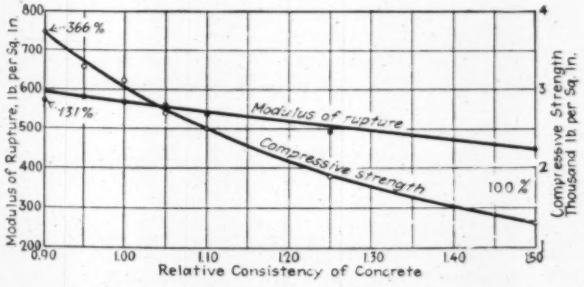


FIG. 2—EFFECT OF QUANTITY OF MIXING WATER ON STRENGTH AT 28 DAYS

Using 0 to 1½-in. sand-pebble aggregate; mix, 1:4 by volume; age of test, 28 days.

department (H. S. Mattimore, testing engineer) on the relative value of beams gives the following results:

6 x 8 x 36-in. beams broken on 24-in centers		
Mix	1:2:3	1:2:4
Relative value	100	109.3
North Carolina State Highway		
Mix	1:1½:3 (6-in. thickness)	1:2:5 (7-in. thickness)
Relative value	100	104

Table II gives moduli of rupture and compressive strength for different gradings of aggregates. From a paper on "transverse tests as a criterion of the quality of concrete" delivered before the American Society of Testing Materials, Mr. Mattimore has the following to say:

It has been definitely established as a result of tests on experimental roads that the transverse stress is the critical stress in a road slab, and, hence, that the modulus of rupture of concrete is a most important property in determining the strength of the slab.

Conclusions—1. That a 1:2 ratio between the cement and fine aggregate gives the best wearing surface both from an economic and a wear standpoint for portland cement concrete roads.

2. That as much coarse aggregate should be used as the voids in the coarse aggregate will permit so long as a concrete that can be worked is obtained.

3. That the transverse stress of the slab should be the criterion in preference to the compressive strength of the concrete used in the slab.

TABLE II—CONCRETE STRENGTH FOR DIFFERENT AGGREGATE GRADINGS

(Data from the Structural Materials Research Laboratory Bulletin 11—Table 4)

Ref. No.	Passing ¾-in. Screen	Retained on ¾-in. Screen	Modulus of Rupture Lb. per sq.in. 28 Days	Modulus of Rupture Lb. per sq.in. 1 Year	Compressive Strength Lb. per sq.in. 28 Days	Compressive Strength Lb. per sq.in. 1 Year
36	100	0	160	340	620	1,600
37	100	0	195	370	850	1,860
38	100	0	250	425	1,010	2,100
29	92	8	255	450	1,290	2,330
30	75	25	390	570	2,008	3,230
31	66	33	485	645	2,190	3,830
32	59	41	505	710	2,410	4,510
33	55	45	555	820	2,940	5,340
35	37	63	590	865	1,990	4,080

Garbage Collection Methods and Costs at Victoria, B. C.

IN Victoria, B. C., garbage is collected by motor trucks, using day labor under supervision of the city engineering department, and then hauled to a wharf from which it is towed out to sea and dumped by contract, according to a paper by F. M. Preston, city engineer of Victoria, in *The Canadian Engineer*, July 19, 1927, p. 141. Two small refuse burners are located on the wharf for use in disposing of combustible material which is hauled with the garbage.

Residence collection is made every 8 to 10 days without charge, while all types of commercial businesses may have collection any time on demand at a charge of 15c. per can. Standard-sized cans made by the city are required having a capacity of 3½ cu.ft. The cans are rented for a charge of $4.20 each, covering the life of the can. When the can has ceased its usefulness, a red card is left by the collector notifying the occupant that the can must be renewed. When the next collection is made, the old can is also removed, and no further collections are made until a new can has been provided.

Four trucks are used for collection with capacities from 3½ to 12 cu.yd., each specially designed for the district which it serves.

In 1926 the total cost for garbage collection was $29,000, which included $5,507 for sea dumping. This represented the cost of collecting 21,701 cu.yd. from residential districts and 3,280 cu.yd. from commercial districts. The cost per cubic yard was given as 63c. as compared with a cost of $1.40 in 1919 when the collection in the city was made entirely by horse-drawn vehicles.

Drainage Extends Suburban Area of New Orleans

Hydraulic-Fill Levees Exclude Seepage and Flood Water—Canals Lead Drainage Water to Four Pumping Stations with Eight Screw-Pump Oil-Engine Units

A LAND drainage project which includes ditches, levees and oil-engine pumping plants, but which has the rather unusual purpose of draining a tract of land for residential instead of agricultural purposes, is that of the Fourth Jefferson Drainage District adjacent to the city of New Orleans. This project provides a new residential district for the expansion of the city.

On the drained area of New Orleans which lies too low for natural drainage, comprising approximately 30,000 acres, all the rainfall not disposed of by evaporation is collected by means of a system of closed and open drains leading to a number of pumping stations at which the water is raised and discharged into adjacent lakes and bayous. During the past few years there has been a marked residential development westward, up the Mississippi River, and this development is now extending over the upper limits of the city and into that portion of Jefferson Parish which extends from the Mississippi River to Lake Pontchartrain.

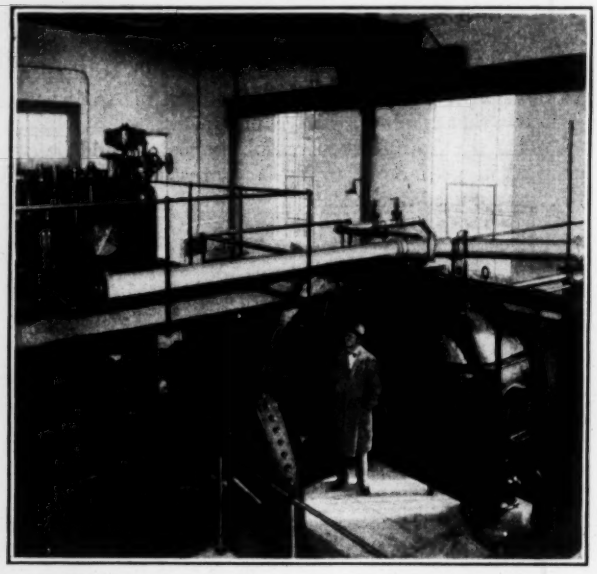


FIG. 1—OIL-ENGINE AND SCREW PUMP UNIT

About fifteen years ago, in order to perfect the drainage of the westerly portion of the city, it was found advisable to include an adjacent area of 2,200 acres in Jefferson Parish, fronting on the Mississippi River. This area, now thoroughly drained, is becoming an attractive residential suburb. While the demand for further residential expansion in Jefferson Parish has been insistent, extensive drainage operations were first necessary in order to permit proper development. Jefferson Parish, like the city of New Orleans, is made up of a narrow strip of relatively high land, immediately adjacent to the Mississippi River, with the remaining portions of its area little, if any, above the mean water level of Lake Pontchartrain.

Drainage District—To provide for the drainage of this area, all the land in the parish extending between the Mississippi River and Lake Pontchartrain, with a 10-mile frontage on the lake, was created into a drainage district in 1922. It is designated as the Fourth Jefferson Drainage District, comprising about 31,200 acres, the drainage of 2,200 acres as undertaken by New Orleans being here described. Complete surveys were made during 1922 and 1923, and plans for drainage of the remaining 29,000 acres were adopted by the Board of Commissioners of the district in May, 1923. In November, the district court of the parish confirmed the report of the Board of Appraisers which, according to law, had assessed against all lands and other property the benefits that would accrue from the carrying out of the adopted plans for reclamation. These benefits totaled $3,129,729, and in 1924 a bond issue of $2,000,000 was levied and sold by the district to provide the necessary reclamation funds.

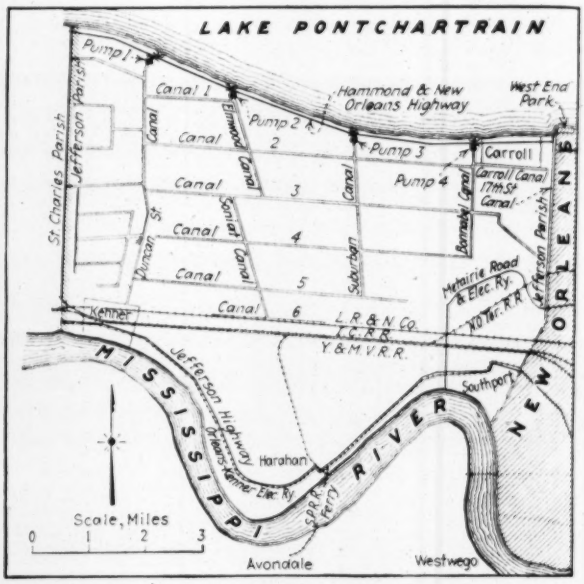


FIG. 2—JEFFERSON DRAINAGE DISTRICT; LOUISIANA

This reclamation plan calls for the construction of levees to protect the area from outside overflow, a system of ditches and canals to collect the surplus rainwater within the district and conduct it to the pumping stations, and the construction of four pumping stations to elevate and discharge the drainage waters into Lake Pontchartrain.

In this district the average annual rainfall is 56 in. The lands fronting on Lake Pontchartrain are subject to tropical storms, which occur usually between late August and early October, but these storms seldom raise the normal water level in the lake more than 3 ft. However, the worst storm on record [not taking into consideration the downpour of nearly 15 in. in 24 hr., on April 14 and 15, 1927], on Sept. 29, 1925, probably raised the level as much as 6 ft., and for this reason the lake front protection levee was constructed 8 ft.

above normal water level. Seepage water will be eliminated by the cutoff in the hydraulic-fill levees. Until more intense development takes place, sewage will be handled by individual septic tanks.

Landowners have granted 150-ft. rights-of-way along the routes of main drainage canals, so that highways may be constructed on each side. In time, these canals will be converted into closed drains and parkways will be constructed over them, as has been done in New Orleans. No general plan for additional streets has been decided upon, but an association of property owners is working on such a plan. While the lands are owned by several thousands of persons or corporations, the association mentioned above is endeavoring to keep development along normal lines and to co-ordinate the efforts of the various developers.

Land which is high and dry enough is now largely built up or used for truck gardens. As the present wet lands become available through drainage, they will be utilized as farms and gardens until residential development is extended. As to structures, those erected on piling will not be affected by subsidence of the surface soil due to drainage, while small buildings can be erected on spread foundations without trouble, as in portions of New Orleans which have been drained recently and are of similar formation.

Levee Construction—Along the 10-mile frontage on Lake Pontchartrain, from the New Orleans city limits to the St. Charles Parish line, a levee protects the District not only from usual high water elevations in the lake but also from the effects of storm waters due to the tropical hurricanes that occasionally strike the Louisiana coast. Here the soil consists principally of muck, 8 to 12 ft. in depth, below which is Mississippi River silt and then sandy clay extending to great depths. As this surface muck is not suitable for protection levee purposes, due to its extreme porosity, an unusual method of levee construction was adopted.

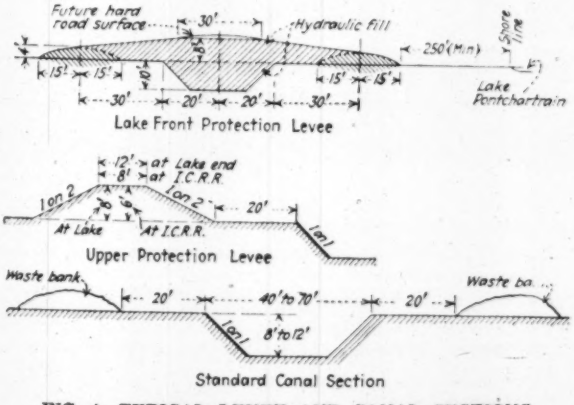


FIG. 4—TYPICAL LEVEE AND CANAL SECTIONS
Note cutoff in levee to exclude seepage.

A floating dipper dredge first excavated a canal paralleling the lake shore at an approximate distance of 300 ft. and of such depth as to cut entirely through the surface muck and reach the underlying firm soil. The spoil from this canal, which has a bottom width of 45 ft. and an average depth of 10 ft., was deposited in equal amounts on each side of the canal, forming two continuous embankments 4 ft. high, with their crests approximately 120 ft. apart. Then a floating hydraulic dredge with 20-in. pump, stationed not less than 500 ft. from the lake shore, pumped into the canal and the space between the two spoil banks the sandy clay material found in the bed of Lake Pontchartrain. The crest of the hydraulic fill was 8 ft. above mean water level, with side slopes of 1 to 10. This embankment forms an impervious and storm proof levee and will carry Lake Front Highway which the State Highway Department is constructing into New Orleans.

FIG. 3—DRAINAGE PUMPING STATION
Note bell-mouth of suction pipes and oil-engine exhaust mufflers. Fuel-oil tank mounted in tower beneath water tank.

Canals—Floating equipment was used to dredge the main drainage canals, which vary in width from 40 to 70 ft., have depths ranging from 8 to 12 ft. and aggregate 60 miles in length. The district will also construct about 20 miles of smaller ditches, 8 to 20 ft. wide, in the area between the river and the railroad embankments.

Pumping Stations—Near the lake end of each of the four main north and south canals is a pumping station, the four stations having a combined pumping capacity of 1,000,000 gal. per min. at 7-ft. static head, which is equivalent to the removal of 1½ in. of rainfall within 24 hours.

Each station extends across its respective canal, its foundation being connected with the levee system and acting as a dam to prevent the passage of lake water back into the canal. The stations are 40x70 ft. in plan, with a clear height of 20 ft. between floor and roof trusses. Concrete foundations are supported by pile sub-foundations, with a row of sheetpiling on both the intake and outfall sides and extending on the outfall side into the adjoining canal banks a distance of 20 ft. The superstructure is of steel frame with side walls of interlocking tile stuccoed on the outer sides. Red Spanish tiles cover the roofs. In each station there will be two 80-in. screw pumps, each directly connected to a vertical Diesel

oil-engine of 330 hp. at 215 r.p.m. These engines are capable of utilizing very low grades of fuel oil, should this become necessary in the future. Each station will also have auxiliary equipment consisting of a traveling crane, and a small oil engine for driving priming pumps, service water pumps, air compressor, lighting equipment and small machine tools.

As a large portion of the district is covered with a deep layer of muck, after drainage is complete there will be rapid subsidence from present land levels, amounting possibly to 3 or 4 ft. within the next five years. For this reason, seven of the eight main pumping units have been designed for maximum lifts of 10 ft., while the eighth pump can be operated under a static head of 14 ft. This high-head pump is a duplicate of the other seven except in its impeller, but necessarily has considerably less capacity. However, as land subsidence takes place and the necessity for higher lifts occurs, the impellers of the other seven pumps can gradually be replaced by high-lift impellers without altering the power of the main engines. When the pumping capacity becomes too much reduced by such changes, one or more of the stations can be lengthened to admit additional pumping units.

Special features were involved in the design of these 80-in. screw pumps. For drainage work in this vicinity the lift is relatively low, but the range in working head represents a high percentage of the total lift. Further, the large capacity of the pumps necessitated a large impeller, requiring a lower speed than is said to be practicable for direct connection to oil engines. This combination presented problems in fitting the engine to the pump requirements without involving excessive power in the engine to take care of the maximum power conditions, which with a screw pump are encountered at the higher lifts. With a centrifugal impeller the tendency is to overload the engine at low lifts, and by combining certain characteristics of such an impeller in the screw impeller, the horsepower peak is flattened considerably.

Another feature is that the impellers are hydraulically balanced, so that only a small thrust bearing is required, instead of the large marine-type thrust bearing ordinarily required for large screw pumps. This improvement is effected by sealing the back portion of the impeller from the discharge side of the pump, and transferring to this sealed space the vacuum from the suction pump. In this way the thrust is practically counterbalanced. The length of the pump is short in relation to its diameter, thus reducing the size of foundations and building. For the one high-lift pump mentioned, the vanes of the impeller have a smaller pitch, relative to the axis of the impeller, than those used with the low-lift pumps.

Engineers and Builders—The plans for draining the district were prepared by and carried out under the direction of Allan T. Dusenbury, consulting engineer.

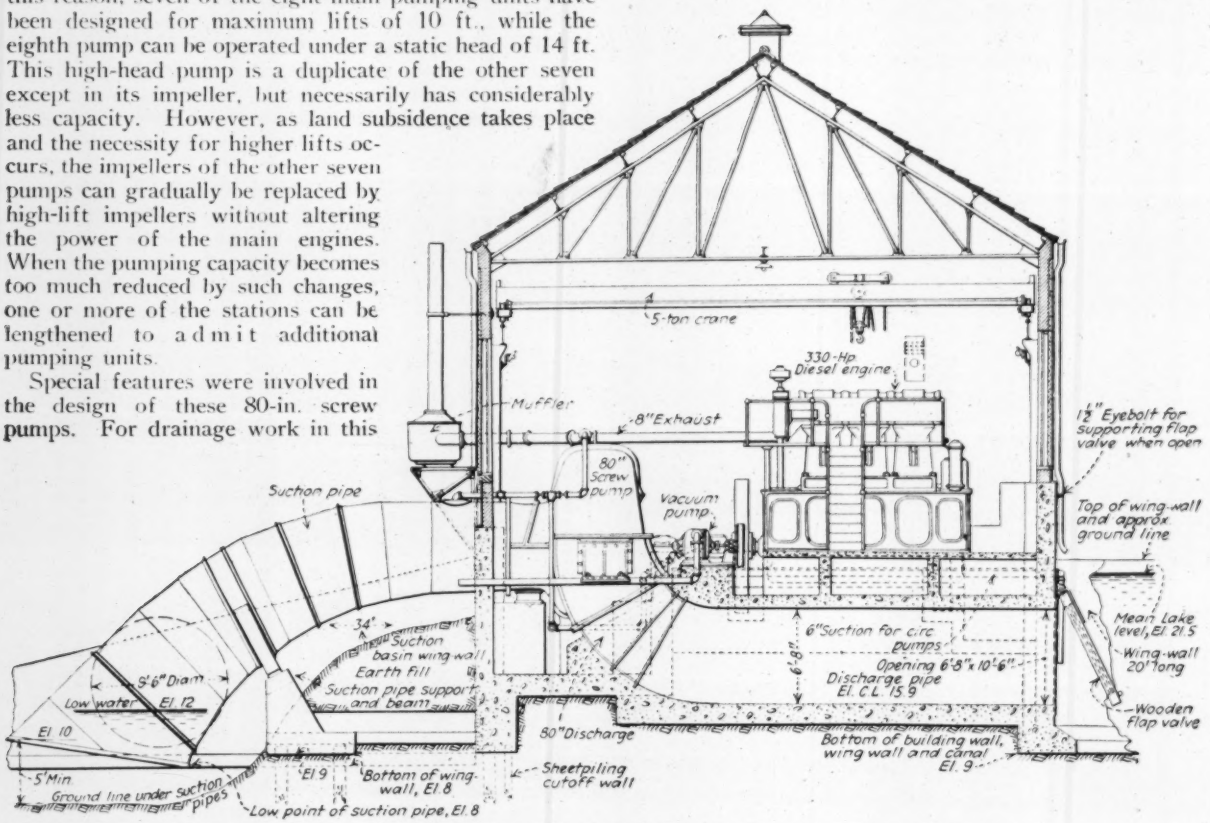


FIG. 5—DRAINAGE PUMPING STATION WITH OIL ENGINE AND SCREW PUMP

New Orleans, La. The canal and levee systems have been constructed by the McWilliams Co., Memphis, Tenn., and the Reynolds Dredging Co., New Orleans, La., under a joint contract. A. M. Lockett & Co., New Orleans, had the contract for complete installation of the four pumping plants.

Montreal Spends Large Sum on 1926 Paving

The city of Montreal, Canada, spent $3,152,370 during 1926 for construction of new pavements, sidewalks and sewers, according to a report to the Department of Commerce from Assistant Trade Commissioner Aylwin Probert, Ottawa. The respective amounts were: pavements, $2,215,356; sidewalks, $456,722; and sewers, $480,292. The funds for these improvements were supplied by a working capital account which is a loan fund established for that purpose, against which expenditure assessments are later made on the interested property owners.

Strength of Materials and Some Confusing Teachings

Disagreement of Texts on Lateral Stress—Meaning of "True Stress"—Rupture Due to Strain Without Stress

By D. J. Fee
Assistant Field Engineer, Pacific Gas & Electric Co., Pine Grove, Calif.

IT IS a dangerous experiment for anyone more than six months out of college to dip into such a subject as Strength of Materials. To illustrate the consequences of such an experiment I will describe my recent investigations into the nature of shear, and particularly the relation of shear and direct stresses.

Let it be understood that in this exploration I was guided by an excellent chart—a standard treatise on Strength of Materials, which happens to be the only recent one I possess. The tortuous and bewildering path which I followed is not a reflection on my text, but simply evidence of my inability to read the chart correctly, and understand it, although for those who are young enough it is doubtless quite simple.

Consider then: "When a cylindrical piece is stretched by a longitudinal force, P, it contracts laterally in all directions." This we know, but Fig. 1, from our text, makes it clearer. "Since a longitudinal pull produces lateral contraction, it is often thought by students that there must be a lateral force exerted on a longitudinal plane, like the one represented by the dotted line" (A-B in Fig. 1). We are immediately set right on this point. There cannot conceivably be either tension or compression produced on such a longitudinal plane under these conditions.

We turn a page. Here we have two equations which for a given unit strain (stretch) in one direction, e_x, and a given unit strain at right angles, e_y, give us directly the values of the resultant stresses n_x and n_y in these two directions:

$$n_x = \frac{m E}{m^2 - 1}(e_y + m e_x)$$

$$n_y = \frac{m E}{m^2 - 1}(e_x + m e_y)$$

where m is Poisson's ratio and E is the modulus of elasticity.

It is a natural inference that these equations fit the case of Fig. 1, because we are sure of the two strains, one longitudinal and the other lateral. We are not so sure of the meaning of an equation which gives the value of a stress that is not supposed to exist.

We turn another page. Here is an article giving a logical proof that "in the case of stress parallel to a plane, if there is only shear on any plane, and hence shear of equal intensity on another plane at right angles to the first, there must be pure tension and pure compression of the same intensity as the shear, acting on planes inclined at 45 deg. to the planes of shear" (Fig. 2).

And after much interesting and instructive reading we come to the subject of slip bands, which are harmless enough in themselves, except that we are troubled by the opening remark, "Bearing in mind that tension cannot occur without shear, or shear without tension" ending with a reference to the article above quoted, which for convenience I will call Art. X. There seems to be something missing. *Did* we prove in Art. X that tension cannot occur without shear? Not exactly. We are willing, however, to believe that it can be proven, and then the startling idea dawns upon us that it must also be true that shear cannot occur without both tension *and* compression—by no means a repetition of what we formerly quoted.

With this realization we are brought back to our original cylindrical piece, Fig. 1, stretched by a longitudinal force, P. Putting two and two together: We have tension; therefore we have shear, and therefore (as shear cannot occur without both tension and compression) we have compression at right angles to this tension. There was in fact an actual equation for the value of this compressive stress. All of which flatly contradicts our proposition that there is no stress whatever at right angles to the tension for this very case.

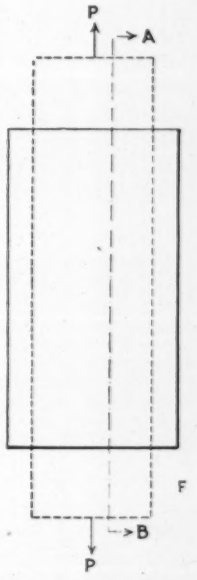


FIG. 1 — TENSION AND LATERAL CONTRACTION

It needs but little thought to convince us that our author is wrong, and that there must be compression; and for verification we turn to a standard civil engineer's handbook, where we find an example with exactly the conditions of Fig. 1, using numerical values, and the concluding statement, "whence it is seen that a true stress" (compressive) "of 2,000 lb. per sq.in. exists at right angles to the direction of the load."

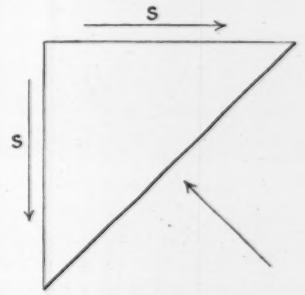


FIG. 2 — NORMAL STRESS RESULTANT OF SHEARS

There is no doubt then, that this compressive stress does really exist, and we can picture the molecules being drawn together and resisting this compression. In our mind's eye we have a picture like Fig. 3, in which the internal stresses shown are those acting on the shaded portion of the cylinder imagined separated from the rest. Mentally we remove this shaded portion, and we have Fig. 4, which is in equilibrium under the forces shown, as is also the portion of the cylinder remaining and shown in Fig. 5. Along the dotted line A-B (Fig. 4) every point is in compression, being squeezed, as it were, in a sort of toggle joint.

We proceed now, under caution, our confidence in texts sadly shaken, but with the satisfaction of having solved a problem of considerable importance.

On a following page we find a repetition of the statement that "a shearing stress alone involves or causes tension and compression of equal intensity with the shear."

There is something vague about this shear being the *cause* of another stress. Usually we think of stress and strain as being in the relation of cause and effect, or both being the effect of an external force; I prefer John Perry's statement, "A shear strain simply consists of a compressive strain in one direction, accompanied by a tensile strain in the perpendicular direction." The same can be said of the stresses. One does not cause the other. One *is* the other. They are both the same.

We now come to a chapter on "Pure Tension and Compression," and to our great dismay are suddenly faced with a convincing proof that everything is all wrong in our old case of Fig. 1. There stands the proof —"On a longitudinal plane there is no stress at all"! And what is our consternation when we see on the very page following a block of wood split by longitudinal cracks as a result of the lateral tensile *strain* accompanying compression. (The inference is clear that this is a parallel case to ours, of lateral compressive strain, accompanying tension.)

This becomes serious. To have this proposition proved and disproved in such rapid succession is decidedly trying, and if reversal of mental stress is similar to physical, may even have ill effects. Let me emphasize, however, that I am not primarily attempting a criticism of my treatise on Strength of Materials, which is justly accorded a place of very first rank. I am endeavoring to expose pitfalls which a student digs for himself, aided and abetted by a confusing nomenclature peculiar to this subject.

This chapter on Pure Tension and Compression is, after all, the starting point of the true solution of our difficulties. The key to the solution is contained in the remark that, "It must not be supposed that in such a piece, however" (meaning a piece under pure tension) "there is only tension." Thus in a piece subjected to "pure tension" it must not be supposed that there is only tension. There seems to be something singularly impure in this use of the English language, and the confusion is caused by using the term, "pure tension" to define the condition of stress throughout a body, generally (not on one particular plane) under certain conditions of loading; and using the same term, "pure tension," to mean the condition of stress on a plane—on one singular and unique plane at any given point.

For example, in one chapter is the statement that "A piece is in pure tension or compression when its axis is and remains straight and vertical, and when it is subjected to two equal and opposite forces, one at each end and uniformly distributed over the section." This defines the stress on all planes at all points, while the "pure tension" of Art. X is a condition peculiar to one plane. The distinction will simplify many of the peculiar remarks that are made about pure tension, pure compression, and pure shear.

Now let us return to Fig. 4, on which we showed previously some of the stresses which exist, but not all. The true stresses should be shown as in Fig. 6, where it appears that we have normal stresses as well as shearing stresses. It is quite a simple matter to see that the shearing force, S, which actually acts, as shown, is but one component of the resultant force, R, acting vertically. By a fundamental rule of thought, which our text calls the principle of superposition of effects, we are justified in supposing that this shear component, S, does actually produce a compression along A-B; it must, as it has a component in that direction; but we are not at liberty to forget the other component, t, which produces a tension along A-B. One effect counteracts the other, and the resultant stress is zero. In the vertical direction, the components of S and t do not counteract each other, but both added equal the single force R, the resultant of all forces on the plane.

Of course it is simpler to start with the resultant, and say, straight off, that a vertical force can have no horizontal component. But the existence of that horizontal component of diagonal shear has been so em-

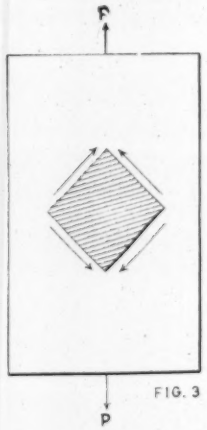


FIG. 3

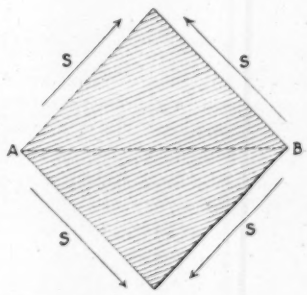


FIG. 4

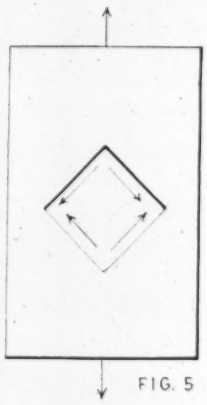


FIG. 5

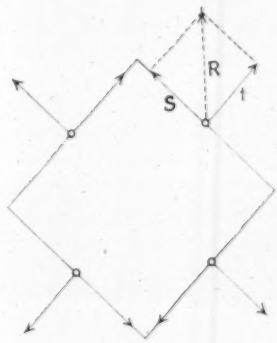


FIG. 6

FIGS. 3-6—INTERNAL SHEARS IN TENSION BAR
Fig. 3—Elementary diagonal cube. Fig. 4—Shears on cube. Fig. 5—Shears on bar. Fig. 6—Full stress on cube.

phasized that it is well to understand clearly how it must in this case be counteracted.

Our final conclusion, which this time shall stand, thus proves to be that no compression or stress of any kind acts in a lateral direction on the longitudinal plane A-B of Fig. 1, as stated by our text. But it may be well to dispose of the causes which misled us into believing that such a lateral stress could exist, and in this I will depart from my original intention, to the extent of giving full credit to careless or inaccurate treatment of texts when, as is too frequently the case, this proves the main source of difficulty. This is known technically as passing the buck.

First there was the equation for the value of this lateral stress. To our genuine surprise this equation shows that for a lateral strain in the proportion of Poisson's ratio to the longitudinal strain (such as we assumed in Fig. 1) the value of the lateral stress is zero, thus proving, not that no compression exists but that we actually *assumed no stress to exist*, in our method

of deriving the equation, which as sometimes happens in applied mathematics implies more than is understood.

Next there was the misleading and erroneous statement, "Bearing in mind that tension cannot occur without shear or shear without tension (Art. X)." Here tension means the condition of stress generally throughout a body, or a condition of loading, since in continuing the author says, "A piece exposed to tension, etc." But by the reference to Art. X, in which "pure tension" has solely its other meaning of condition of stress on a single plane, it is clear that the ideas have been confused; one used in the proof (Art. X), and another in the conclusion, which, as stated, is incorrect. Tension (on a single plane), or tension (a condition of loading) can occur without shear if the two principal stresses are equal tensions. Tension (a condition of loading) *cannot* occur without shear, if the definition is restricted to *two* equal and opposite forces as the author happens for the moment to intend, but no reference to Art. X will make it so, because this article is talking about something else, unfortunately under the same name. A simple and obvious proof is that provided by any plane section cutting the axis diagonally.

Thirdly we come to the Handbook, "true stress of 2,000 lb. per sq.in." which appeared to clinch the matter. This is an example of the disadvantage of adopting a word from common language and giving it a meaning just the reverse of what it generally means. Our text calls this "true" stress, "the *imaginary simple stress* which acting alone would produce the same strain as is due to the actual stresses," with the result that we know what we are talking about. No amount of explaining by our Handbook will make us believe that the true stress is not the true stress. We simply persist in giving the word "true" its true meaning of true.

And finally regarding the piece of wood with longitudinal rupture, caused by transverse *strain* (no transverse stress), our text states that this occurs when the resistance to tensile "strain" is small. But how the resistance to tensile strain can be anything at all, without the existence of tensile stress, it is difficult to see. What manner of resistance is this, which is not a physical force, that is, an internal stress?

This is a complex occurrence, this rupture of a complex thing such as a piece of wood. I would not attempt an explanation of it. Fortunately our understanding of stresses under ordinary conditions does not depend on the causes or conditions of rupture, of which we know very little. The only justification for introducing this example is that it was thrust upon us by its unfortunate implying, but denying, the existence of lateral stress.

The attempt to analyze this subject from the learner's viewpoint thus results in a criticism on important points of up-to-date authorities. It should not be possible to ascribe a student's difficulties to such a source, and would not be were the subject treated with the care it deserves.

Panama Canal Traffic Largely Oil

Tanker traffic through the Panama Canal was greater for the fiscal year 1927, than for any year previous, with the exception of 1924. Of these ships, 1,324 passed through, carrying a total of 7,250 tons of mineral oil products, the tolls on which amounted to $6,658,906.90, or 27.5 per cent of the total collected for the year. Tank ships comprised 24.2 per cent of the total commercial transits, and 26.1 per cent of all cargo entering the canal.

Welding Pure Aluminum—Flux and Operation Requirements

THE following information, taken from an article in *Oxy-Acetylene Tips*, May, 1927, gives a welding procedure for one of the most important and widely used of the non-ferrous metals, aluminum. A welding operator, even though experienced on steel and cast iron, who is attempting to weld aluminum sheet for the first time, should make practice welds which he can test to destruction. Aluminum is 99 per cent pure or better and thus requires a different welding procedure than do a number of its alloys. In addition to this aluminum sheets vary in number of grades and tempers, which also causes a variable weldability.

Aluminum differs from most metals in that it does not become red hot but maintains its characteristic silvery white color even in the fluid state. The metal oxidizes very rapidly, and the resulting oxide has a melting point much higher than the melting point of aluminum. The oxide is also lighter than the metal and consequently forms on the outside of the weld in a heavy thick skin which must be removed from the aluminum sheet by means of a proper flux when it becomes so heavy as to interfere with the welding.

A further condition is that aluminum, like copper, has a very high rate of thermal conductivity. It is thus desirable to support carefully all parts adjacent to the weld that are likely to become rapidly heated, and to complete the weld as quickly as is consistent with good workmanship, using in the welding a flame of minimum size.

Proper flux and good drawn aluminum welding rods are of the utmost importance. It is undesirable under any conditions to use ordinary aluminum wire for welding rod because of the variation in its composition. Most aluminum fluxes are sold as a thick paste or powder, which when mixed with water to a free-flowing consistency are applied with a brush to the welding rod. A flux container filled to within an inch of the top with flux and water solution is used in which the supply of welding rods is kept.

Aluminum sheet of 16 gage and lighter is usually flanged in preparation for welding, the flange being about the same height as the thickness of the sheet. Heavier sheet and light plate can be welded with a plain butt weld. One design of butt joint uses notches spaced across the joint as close as ¼ in. These notches make it easier to obtain full penetration, besides acting as expansion joints. In ¼-in. and ⅜-in. material, one of the abutting edges can be notched in this manner, while the other one is beveled 45 deg.

For welding sheet aluminum the blow-pipe should be carefully adjusted to show a neutral flame which should be applied at an angle of about 30 deg. to the surface of the sheet. Completed welds are sometimes washed with a 10 per cent solution of sulphuric or hydrochloric acid to remove all trace of excess flux. After this treatment, welds should be scrubbed in large volumes of warm water to remove any of this acid solution that may be left. Another method of flux removal consists in washing the article in hot soapy water, followed by a hot rinse. Sometimes little pockets of flux are entrapped during welding and these may be removed by means of a steam jet.

Frank C. Wight, Engineer and Editor

The Man and His Work as Seen By His Professional Friends

Many letters and messages have come from friends of Frank Wight deploring his untimely death. As they present a truer and broader picture of that brilliant and talented personality than any single impression, a few passages selected from them are printed here. They constitute that fuller appraisal of the editor, engineer and man which our lines of appreciation last week could not give.

THE shock of the news of Frank Wight's death is too numbing to permit me adequately to write about him. As one gets older, friends depart and no one can come to fill the vacant places. Especially so in the person of Frank Wight, a genial companion and a warrior for right and justice, with an utter contempt for anything less than the highest in practices attending engineering. He came in his time to express the soul that has lived in a leading engineering journal. I shall miss his quick wit and mental energy that drove to the center of any question under discussion.

Lafayette, Ind. W. K. HATT,
Head, School of Civil Engineering,
Purdue University.

Frank C. Wight was an outstanding engineer and engineering writer. I knew him intimately for many years and had an increasing appreciation of his ability as an engineer, of his knowledge of the needs of the engineering profession, and of his sterling character as a man. His influence was especially helpful to engineering education and to the younger members of the profession. In his death, the engineering profession has lost a distinguished member, and I have lost a friend.

Urbana, Ill. M. S. KETCHUM,
Dean, College of Engineering,
University of Illinois.

I was deeply grieved to learn of the death of Frank C. Wight, editor of *Engineering News-Record* and president of the National Conference of Business Paper Editors. I knew Mr. Wight from his attendance upon our business editors meetings and was greatly impressed with his ability. Mr. Wight had a high sense of duty to the engineering profession. His influence will continue.

Washington. HERBERT HOOVER.

Few men have so rapidly reached such eminence as Frank C. Wight attained in his chosen work. His going is a lamentable loss both to engineering and to technical journalism, for he had a talent in both professions that is rarely found to a like degree in combination. He had a highly developed journalistic sense and the right appraisal of news and editorial values. His industry, capacity, courage, fairness and friendliness were marked traits, and he had another that counts for much in the making of an editor—a willingness to go the second mile.

New York City. A. I. FINDLEY,
Editor, *The Iron Age*.

The death of Frank C. Wight must be a real loss to your great institution. It is an even greater loss to America and the world. Under his editorship *Engineering News-Record* has not only maintained its leadership in its technical field, it has become also increasingly an inspiration to the civil engineering profession for sound and liberal leadership in public and economic affairs. He will be greatly missed among those who are interested not only in civil but in civic and social engineering.

New York City. HAROLD S. BUTTENHEIM,
Editor, *The American City*.

I have always had a high appreciation of his forceful character and the courage with which he stood for the things which he believed to be right. His passing is a great loss not only to his friends but to the business papers, among the editors of which he was regarded as one of the outstanding leaders.

New York City. ROY V. WRIGHT,
Managing Editor, *Railway Age*.

Frank C. Wight was a man of exceptional qualities, including a great interest in and loyalty to his work. You will miss him immeasurably, and I trust that his desire to get at the truth of important matters which concerned the engineering profession will remain with your publication.

Washington. EDGAR JADWIN, Major General,
Chief of Engineers, U. S. Army.

I cannot tell you how much I am shocked to hear of Mr. Wight's sudden death. I knew him very pleasantly for several years and was always impressed with his pleasant and gracious personality, his wide viewpoint on matters engineering, and his fearless championship of the right, no matter who was on the other side. His passing will be a great loss to your paper, to the engineering profession, and to his many personal friends, of whom I had the honor to be one.

St. Louis. CHARLES L. POTTER, Colonel,
Corps of Engineers, U. S. Army,
President, Mississippi River Commission.

A valued friend and co-worker has been lost to me.

New York City. GEORGE T. SEABURY,
Secretary, American Society
of Civil Engineers.

The civil engineering profession has indeed suffered a loss in the death of Frank Wight, and the field of technical journalism has lost one of its leaders. I had come to admire him for the many outstanding qualities that had brought him in the prime of life to a position of great responsibility and of high service to the engineering profession and the public. His advice and suggestions regarding the society's activities, both technical and on questions of policy, were always welcomed and valued. Those of us who knew him personally have lost a real friend in his passing.

Philadelphia. C. L. WARWICK,
Secretary-Treasurer, American Society for
Testing Materials.

Frank Wight's death was a shock to all of us. His passing is a loss to the whole engineering field. Your organization has our sincerest sympathy.

Chicago. WILLIAM M. KINNEY,
General Manager, Portland Cement
Association.

Few of his friends can realize what a loss his death means to the contracting fraternity. We had come to rely upon the wisdom of his counsel and the fairness of his thinking. That keen penetration of his into the economics of both contracting and engineering and his courage to stand by his own convictions are things which this tumultuous industry can ill afford to lose. We shall miss both his counsel and his friendship.

Washington. R. C. MARSHALL, JR.
General Manager, The Associated General
Contractors.

News of the death of Frank Wight affected me more deeply than I can say. For years I have known him not only as a business acquaintance but as a friend whose qualities I admired and whose friendship I prized. It is sad to think that so useful a life should be taken in its prime from those he loved.

New York City. EDWARD D. BOYER,
Atlas Portland Cement Co.

As a fellow townsman of Frank Wight, it was my privilege to know him well. He had an exceedingly alert mind, was a clear thinker, and enthusiastic to a degree concerning his work. He was kindly and considerate of the views of others even though they did not entirely coincide with his own, but he was impatient of chicanery and fraud. His mind worked along simple and direct lines, and his judgment of men and things was remarkably good. He leaves behind him the affection and regard of all those who had the privilege of knowing him at all well. Through his death many of us have lost a capable adviser and a sincere friend.

New York City. G. EDWARD ESCHER,
President, White Construction Co.

It is with deep sorrow that I have read of the death of Frank Wight, which I know must have been a great blow to those closely associated with him, as it was to his many other friends. I desire to express my regard for Wight as a man, professionally and socially. His death will be a great loss.

Buffalo. J. W. COWPER,
The John W. Cowper Co.

Wight's sudden death will leave a vacant space in the meetings and gatherings of the committees and associations in which he had taken such an active part. There was such a refreshing and stimulating influence from personal contact with him that one always felt life had been made richer and better. You and your associates will feel the loss of such a loyal co-worker and splendid character, but we on the outside will also miss him.

New York City. JOHN G. AHLERS,
Barney-Ahlers Co.

Frank Wight brought to his editorial discussion of the engineering problems in industry a knowledge, interest and fair judgment which made his interpretations of value both to the industry and to the public. His delightful personality and sympathetic interest made him an always welcome visitor at technical meetings, while his suggestions were always of value. I shall miss his presence and judgment very much.

Albany. F. W. KELLEY,
President, North American Cement Corporation.

Wight was one of the most able, conscientious and indefatigable workers with whom I have ever come in contact. I was associated with him something over twenty years ago, and he was held in universal esteem by all of us and we forecast for him a most brilliant career. Since he came to New York, I have watched his progress as an engineer and editor, and his early promise has been more than justified. He was an idealist with a practical sense and courage that enabled him to make his ideals effective in his every-day journalism.

New York City. W. J. DOUGLAS,
Parsons, Klapp, Brinckerhoff & Douglas.

The sudden death of Frank C. Wight is a painful shock to every one whose privilege it has been to know this wonderful, real man. In his going, the profession loses a great force that was always working for higher engineering standards and better recognition by the public of the value of the work it receives at our hands. Like many another unheralded gifted and successful man, his efforts were always devoid of self interest, and were designed primarily to do his job well. His friends are all better men because of the work he has left.

New York City. HUGH L. COOPER.

The news of the untimely death of Frank C. Wight came to me as a great shock and made me feel I had suffered a personal loss. I had learned not only to admire and respect his work as the head of the editorial staff of *Engineering News-Record*, but to have an affection for him as a friend. He was one of those men whose friendship was inspiring, and one never met him without feeling better for the contact.

New York City. ROBERT RIDGWAY,
Chief Engineer, Board of Transportation, of New York City.

Engineering News-Record has lost a capable and brilliant editor, and the engineering profession has lost a good friend who had done much to encourage high standards in ethics and workmanship. Mr. Wight's happy faculty of meeting his fellow engineers in a characteristic cordial and sympathetic manner has formed many friends who will keenly miss him.

Boston. HARRISON P. EDDY,
Metcalf & Eddy.

In the death of Frank Wight, the engineering profession has lost one of its staunchest friends.

Portland, Ore. JOHN C. STEVENS.

Frank C. Wight is mourned by the entire engineering profession. His keen insight into the large problems which confronted the profession, particularly in its relation to the public, and his desire to secure for it the full recognition of its functions in the modern social, economic and political structure of the country, coupled with a willingness to lend personal effort and sacrifice to attain the desired end, have compelled universal admiration and appreciation. The profession has suffered a severe loss.

San Francisco. C. E. GRUNSKY.

Fair, fearless, and frank on all occasions, he had gained the esteem of the engineering profession. Always eager for the truth, once he had found it he followed it without swerving. You have lost a great leader and the engineering profession has lost one of its most valued members and one of its ablest and staunchest defenders.

San Francisco. WALTER L. HUBER.

Through sheer ability as a forceful writer and because of the sound views that he held on the ways and means of promoting engineering in its broadest and most substantial sense, he became one of the progressive leaders in the work of advancing the status of the profession. The product of his endeavor stands as a monument of such character that mere words at this time must remain entirely inadequate. The degree of success of the engineer depends upon the value of the service that he can render to society, and through the teachings of Mr. Wight the engineering profession has been lifted to a higher plane. Every one in the community is the loser because of his passing.

Detroit. GEORGE H. FENKELL,
General Manager, Department of Water Supply.

While your organization has lost a most excellent man, the greatest loss falls on the engineering profession. During my long acquaintance with Mr. Wight he always exhibited an earnest desire to uphold the highest ideals of the profession.

St. Louis. BAXTER L. BROWN.

The news of Frank Wight's death brings a feeling of deep personal loss. He combined in a most unusual degree an attractive personality, a well balanced sense of news value, and a devoted loyalty to the profession which he honored. The engineering profession has been enriched by what Mr. Wight has brought to it both through his selection of material for publication and by his editorial comments and contributions.

New Orleans. ARTHUR M. SHAW.

Those who were privileged to know Frank Wight could not escape the unconscious influence of his lofty character and devotion to ideals. The rare depth and genuineness of his convictions, the irrepressible voice of his conscience, the unusual resources of his reasoning, his gifted power of expressing knowledge, and above all his rugged and impersonal loyalty to principle, were among the many qualities which justly earned for him a proud position in the thoughts of his fellow men. Few there are who have rendered a more conspicuous or unselfish service to the engineering profession than did he. His untimely passing at the very height of his usefulness brings to the hearts of a multitude of friends and admirers a sense of profound sadness.

Boston. CHARLES R. GOW.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

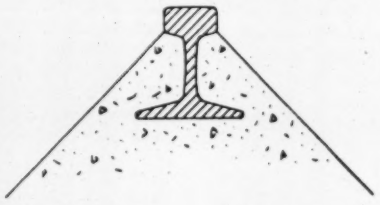
Construction Fire Hazards

Sir—Your editorial on the fire hazards of construction timbering or falsework, in *Engineering News-Record* of Sept. 8, p. 375, suggests the greater use of metal forms and steel falsework, but does not refer to the possible use of fireproofed lumber for temporary structures. Such lumber is on the market, though it is not known whether it has been used for this purpose. It should be much cheaper than steel. It is understood that the New York building code requires the use of fireproofed lumber for flooring and trim in buildings of more than a specified height.

Chicago, Ill. CONSTRUCTION.
Sept. 14, 1927.

Ice-Breaking Pier Noses

Sir—Mr. Kirkham's article given in the Sept. 1 issue of *Engineering News-Record*, p. 354, on the design of ice-breaking noses for piers brings to mind a performance record recently investigated by the writer in the Pittsburgh district. Two types of pier nose which had been in service on railroad bridge piers for a long period and under identical conditions were inspected, one type being the conventional steel angle nose and the other a special one using an 80-lb. rail embedded in concrete (see figure herewith).



The difference in results was quite obvious. The angle, being of comparatively thin section, had corroded appreciably, especially at the toes and also at the points where the countersunk anchor bolts were inserted. This condition had permitted disintegration of the concrete along the edges of the angle for its entire effective length.

The rail section, however, displayed no evidence whatever of deterioration which would affect its practical usefulness, as the heavy head section provided ample metal to withstand excessive corrosion. The bond to the rail was in splendid condition and the entire rail appeared to be well secured in the pier. The faces of the pier were examined for cracks which might have resulted from cleavage caused by the base of the rail but no evidence of cracking could be found. The prevailing conditions were fresh water with a wide range of stage and flow.

Comparison of these two types of noses was predominantly in favor of the rail type. JOHN B. KARCHER,
Pittsburgh, Pa., With Pittsburgh Branch, Byllesby
Sept. 9, 1927. Engineering and Management Corporation.

"Point" not "Section"

Sir—In *Engineering News-Record*, Aug. 25, 1927, p. 300, is published a part of the report of the president of the Mississippi River Commission entitled "Makeup of Breached Levees Given in Report by Colonel Potter." In subparagraph three in the paragraph describing the Mound Landing, Miss., crevasse, this statement is made: "A government inspector, appearing as a witness against the government in the investigation of 1922, is spreading the report that the break occurred at a *point* [italics are mine] where he saw the machine doing bad work prior to that investigation."

I assume that this statement refers to me. If it does it is absolutely false. As a matter of fact, I have never appeared as "a witness against the government in the investigation of 1922" or any other time. I did appear before the Mississippi River Commission at that time as a government employee (levee inspector) and entered what I wanted then, and do now want, to be a protest against the outrageous violations of the levee specifications by the foremen in charge of the machines enlarging and building these levees. I have never made the statement nor spread the report that "this break occurred at a *point* where he saw the machine doing bad work prior to that investigation." As a matter of fact, I never saw "the machine doing bad work," at this point, prior to the investigation or any other time.

Proceeding south from vicinity of Sta. 2750 the machine reached Sta. 3020 and stopped operation for the season 1921. The Mound crevasse occurred about four miles south of Sta. 3020. I had nothing to do with and made no observation in regard to machine work on the levee at the point where the Mound crevasse occurred. I did make the following report: "It was during the enlargement of a section of this levee in 1921 that I told the machine foreman that he was building a levee that would be a menace to the lives and property of the people of the Mississippi Delta for the next twenty years. He replied, 'I don't give a damn what happens twenty years from now. I won't be here to see it.' It was also in regard to a section of this levee that Mr. Thompson, the then chief engineer of the Mississippi Levee District, protested that stumps and logs were buried in it 'literally by the cord.'"

It is customary on the Mississippi to refer to a lineal mile as a "section." It was in this sense I used it, and it is certainly a "section" of this levee.

Carrollton, Miss., S. A. EGGLESTON.
Sept. 3, 1927.

"More on Road Signing"

Sir—I would like to comment on your editorial in the Sept. 1 issue p. 330, "More on Road Signing," which I believe to be very timely. I presume that other sections of the country are placing new signs, as they are doing here in Massachusetts, and which, I understand, is in accordance with standards and in conjunction with the federal government.

In my experience, I find the new type sign satisfactory for it clearly shows direction and gives distance, but I do believe they could be placed to better advantage. Instead of placing them at intersections or junctions, they should be placed about 200 ft. in advance of the intersections, so that when drivers reach intersections, they know the way to go and can give full attention to driving in hazardous places. Our signs for curves, hills railroads, etc., are placed ahead. Why not the signs for directions? H. D. RICKER,
Lynn, Mass., General Electric Co.
Sept. 20, 1927.

Transverse Rolling To Cure Road Corrugation

Sir—Referring to an article in *Engineering News-Record* of Sept. 8, 1927, p. 384, by J. P. McMakin, Catarina, Texas, regarding the causes of corrugation in traffic-bound roads, it has occurred to me that perhaps these are largely due to the action of the road roller. While my experience has not been in road building I have observed that any roller in comparatively soft material will push a small amount of material ahead of it and when a certain amount of it has accumulated the roller will pass over it and then another accumulation will form. These accumulations occur with uniform spacing, depending on the road material.

It seems to me that some experiments could be made along this line to determine whether or not this would be an influential cause of these destructive corrugations. If my theory is a correct one, then the rolling should be done from side to side thereby producing longitudinal corrugations. The action of traffic would have a tendency to iron these out, whereas it has the tendency to increase the transverse corrugations. E. A. STUHRMAN,
Miami, Fla., Consulting Structural Engineer.
Sept. 13, 1927.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Structural Building Stressed at Meeting Of Welding Society

Papers Also Presented on Aircraft Frames and Metallurgy—Research Active

STRUCTURAL matters were strongly represented at the fall meeting of the American Welding Society in Detroit, Sept. 19-22, by two papers on welded buildings, one on steel plate welding work and an interesting and instructive session of the Structural Welding Research Committee. There were also several papers on structural welding of aircraft frames and a paper of general interest on the metallurgy of welds.

At the structural welding research committee session, it was reported that all of the requested funds have been promised by the gas and electric welding interests. The committee's program was outlined and a detailed report given on the 342 pilot specimens that have been prepared (and some tested) by Professor Gillespie of the University of Toronto.

The meeting was unusually well attended. Inspection tours were made to the River Rouge plant of the Ford Motor Co. and to the Ford airport where many of the members took flights in the large all metal Ford planes.

Arc Welding in Buildings

"Arc Welding in Buildings" was the title of a paper presented by Joseph Matte, Jr., construction engineer, Albert Kahn, Inc., Detroit. After an ever-enlarging experience with welding, Mr. Matte has come to the conclusion that "In the present state of the art, steel welding is more expensive than riveting unless some advantage resides inherently in the welding which offsets or overbalances the extra cost." This principle he is using when designing structural connections which lend themselves either to riveting or to welding.

Another present condition is that it is necessary to charge against a large structural job all equipment which it is found necessary to purchase and in this connection Mr. Matte states, "Some new method of co-operation between the welders and the welding supply companies may eventually be worked out, resulting in a material cost reduction." Mr. Matte does not agree with the welding supply manufacturers who state that it is not their job to design the structures. "It is not only necessary for the structural engineer to understand welding, but for the welding engineer to be thoroughly familiar with construction work." At the present stage of the art "it is the province of the welder to come and show us (structural engineers) where, when and how welding is advantageous." Otherwise the structural engineer has no reason to depart from the past orthodox designs.

Among the examples of welding work with which he has been personally connected since 1916, Mr. Matte described a number of interesting structural details. Welding column caps and bases is now done in practically all of the work of his company. It also specifies that all lining rings in large stacks be tack welded in place. For buildings designed and built for the future addition of stories, it has eliminated the costly waterproofing and flashing that had to be provided around the projecting column and now stops the steel columns flush with the temporary roof construction, allowing the waterproofing to run straight across. The column extensions when required can be welded directly to the top of the existing column.

Uses in Concrete Construction

The same solution applies to reinforced-concrete building where a small plate can be anchored in the top of the column flush with the roof slab. The rods for the extension column section can be built up as a unit, set in place and the bottom of the rods welded to this plate. In another case, shear bars in concrete girders were required in such quantities that given their proper anchorage to the top and bottom bars there would hardly be room left to pour the concrete into the forms. The solution was found by welding the ends of the diagonal shear bars between the top and bottom bars. A plan was proposed in Detroit to use welded wind bracing in a building, this to be placed by the welding contractor, thus relieving the steel contractor of the fabrication and erection of these complicated details. As a result a rather elaborate series was carried out which will be described in more detail in an early issue of *Engineering News-Record*.

In another structural building paper, G. H. Danforth, Jones & Laughlin Steel Corp., described the work done on a one-story shop building in which most of the steel was shipped direct from the mill to the site of the building with the usual ½-in. mill variation.

In a paper entitled "Design of Steel Plate Welding" L. J. Sforzini of the engineering and maintenance department, Eastman Kodak Co., made a com-

(Continued on p. 526)

Mississippi River Bridge Span in Ohio Falls During Erection

Semi-Cantilever Method Being Used to Set 314-Ft. Span—Piles Under Temporary Bent Give Way

ON SEPT. 6 a serious erection accident interrupted the construction of the Mississippi River bridge being built for the Missouri-Illinois Bridge Co., at Louisiana, Mo. Erection was in progress from the west or Missouri end. The semi-cantilever method of erection being used is made clear by the picture herewith taken before the collapse. One span had been swung and riveting was in progress; the second span was about two-thirds erected, when the two temporary bents carrying it gave way and the span fell into the river. One man of the erecting force lost his life in the fall.

The bridge will consist of four spans of about 314-ft. length between end pins, one span of 150 ft., and 410 ft. of steel viaduct, with an embankment approach on the east or Illinois side. The spans are riveted through spans, designed to provide a 20-ft. roadway on concrete floor. Harrington, Howard & Ash, of Kansas City, designed the bridge (see *Engineering News-Record*, Sept. 15, p. 431). The piers were being built by the Missouri Valley Bridge & Iron Co., of Leavenworth, Kan., and the superstructure was being furnished and erected by the Wisconsin Bridge & Iron Co., of North Milwaukee, Wis. F. A. Ross, erection manager of the latter company, devised the erection scheme, falsework, and equipment.

In erecting each span, the trusses were cantilevered out progressively over two steel temporary bents carried on pile tower substructures. The first bent was set four panels (about 90 ft.) out from the pier and was connected to the pier by small temporary trusses formed

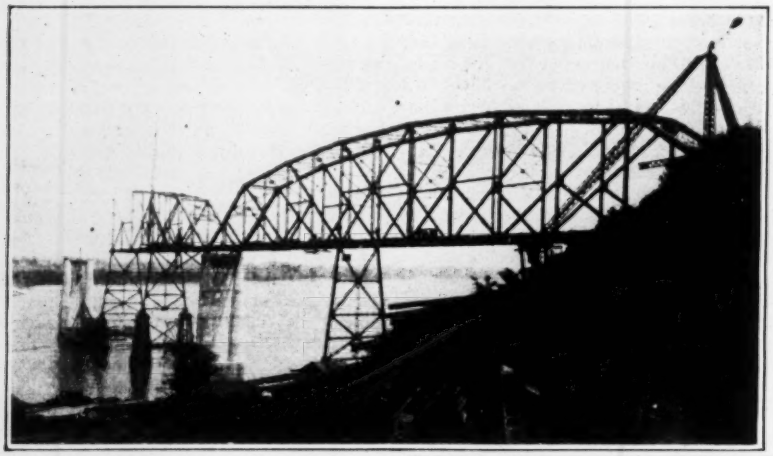
Pratt Institute 40 Years Old

The Pratt Institute of Brooklyn began its 41st year on Sept. 26. The school of science and technology is considered outstanding in practical technical instruction, laying, as it does, emphasis on practical vocational training in both day and evening instruction. Among the subjects taught are structural design, strength of materials, steam power plant operation, automotive engine maintenance and repair, tool making, etc. The director of the school is Samuel S. Edmands.

by a king-post construction riveted to the under side of the bottom chords. When the span had been erected to this bent it was continued by cantilevering to the second bent, and thence continued on to the far pier by cantilevering over the second bent.

E. E. Howard, of Harrington, Howard & Ash, describes the circumstances of the accident as follows:

The bed of the river between pier 1 and pier 2 is in large part of shale without any cover. The pile towers supporting the steel bents were made of groups of substantial timber piles with metal points set on the shale, and braced in all directions



LOUISIANA BRIDGE DURING ERECTION OF SECOND SPAN FROM WEST

above the water line. The piles were unsupported from the water line down to the shale. A few days before the collapse it was observed that the pile falsework towers were being distorted, and were leaning out of correct position. Operations were in progress to provide additional bracing by cables when the span fell. It is the general belief that falsework piles of the outer bent failed by sliding or otherwise, and this bent collapsed, throwing excess load on the bent nearest pier 1, so that this in turn collapsed and dropped the span.

No rivets had been driven, and operations are in progress for raising the span slightly in its present position, removing bolts and taking it apart as far as possible.

H. A. Wagner, president of the Wisconsin Bridge & Iron Co. states that the cause of the falsework failure has not yet been definitely determined, but that further information may be obtained when the span is raised and the piles are examined. He suggests that the river bottom, of hard gravel or soft rock, may not have been penetrated by the piles when driven, and may have permitted uneven settlement later when the maximum load was applied, this settlement transferring load to other piles of the tower and overloading them.

At the inquest on the accident the superintendent of the erectors stated that the falsework was twice as strong as the plans and specifications prepared by the engineers of the company required. He was on the bridge and shortly before the collapse noticed that the falsework was yielding, and thereupon took some men and began to brace the supports. The supports had not slipped or moved before that time, and no evidence of weakness had been observable on the day before (Sept. 5). The closing section of the bottom chord connecting the outer end of the uncompleted truss with pier 2 had been placed in position just before the collapse, but there was no jar or other disturbance during this operation.

UNCOMPLETED SPAN AFTER ITS COLLAPSE DUE TO FALSEWORK FAILURE ON SEPT. 6

Americans Take Prominent Part in Management Congress

Americans took a prominent part in the third International Congress of Scientific Management which was held in Rome during the week of Sept. 5. The Congress attracted 13,000 delegates which included 28 from Great Britain and 32 from the United States. The work of the congress was divided into four sections: industry, agriculture, public services and domestic economy.

Particularly prominent on the program was Morton C. Tuttle of Boston, Mass., who described the organization and management of an engineering construction firm doing from $5,000,000 to $7,500,000 worth of business yearly. Charles R. Hook, of the American Rolling Mill Co., described the application of scientific management principles to the selection and training of employees in the organization with which he is associated.

Evening Classes in Engineering at U. of Cincinnati

An extensive program in evening courses in commerce, engineering and applied arts has been organized by the University of Cincinnati, including civil, mechanical and electrical engineering, architecture, metallurgy, chemistry, traffic management, landscape architecture, radio, advertising, business journalism and real estate. These courses are under the direction of the Dean of the College of Engineering and Commerce.

Ohio Builds Highway to Test Concrete Curing Methods

The Ohio State Highway Department has approved the building of an experimental road in Tuscarawas County for the purpose of testing certain curing processes used on concrete construction. The project is 1.288 miles in length and is located on the New Philadelphia-Millersburg road. The construction is being done by Leroy Springer & Co., of New Philadelphia.

The experimental part of the work will consist of curing certain sections with calcium chloride applied to the surface; calcium chloride as an admixture, sodium silicate on the surface, wet earth and wet straw on the surface.

The experimental work is under the charge of Albert S. Beightler, chief engineer of the bureau of construction. A. S. Rea, chief engineer of tests and Prof. R. C. Sloan, of Ohio State.

U. S. District Court Upholds Minneapolis Zoning Ordinance

Two Decisions Rendered Favor City Though Property Value Is Materially Reduced

Two decisions upholding the zoning ordinance of Minneapolis, Minn., as affecting four property owners in one case and a single property owner in another section in a second case, were rendered by the Federal District Court of Minnesota on Sept. 8. The opinions are given in full in the *United States Daily* (Washington, D. C.) for Sept. 21 and 22.

The validity of the Minneapolis ordinance had already been upheld by the U. S. Supreme Court in a decision rendered on March 21, 1927, involving the exclusion of a four-family apartment house from a one-family residence district (Beery vs. Houghton, 47 Sup. Ct. Rep. 474). There was no written opinion in this case, reference being made to the leading decision of the U. S. Supreme Court dated Nov. 22, 1926, (Village of Euclid, Ohio, vs. Ambler Realty Co., 272 U. S. 365; abstracted at length in *Engineering News-Record*, Dec. 2, 1926, p. 916). Two other U. S. Supreme Court decisions since the ruling decision in the Ohio case may be noted before passing on to the Federal District Court decisions affecting Minneapolis. The third Supreme Court decision (Zahn vs. Board of Public Works of Los Angeles, 47 Sup. Ct. Rep. 594; noted briefly in *Engineering News-Record*, June 2, 1927, p. 917) supported a decision of the highest appellate court of California, which had overruled the lower state court, in the exclusion of a proposed business building from a residence district. The fourth U. S. Supreme Court decision sustained the zoning ordinance of Roanoke, Va., and was rendered on May 31, 1927 (2 U. S. Daily, 597). The effect of this court decision was to compel the property owner to obey the setback requirement of the Roanoke zoning ordinance.

First Minneapolis Case

The first of the Minneapolis cases decided by the Federal District Court on Sept. 8 was a suit in which the American Wood Products Co., the Northwestern Feed Co., T. Benson, and the Lyle Culvert & Road Equipment Co. attempted to compel the building inspector of Minneapolis to permit the use for factory purposes of properties located in district zoned for multiple-family residences. Two of the complainants in this case already had buildings in use for business purposes and wished to extend them. Land adjacent to the property involved is used in part for industrial purposes and in part for residences. The land of the complainants was once zoned as industrial. Later on, the planning commission considered classifying it as "light industrial" property, but decided to put it in the multiple dwelling district.

The final change seems to have resulted from the desire of the Board of Regents of the University of Minnesota "to have no further increase of industry" in that section owing to the rapid expansion of the university in that direction, which has resulted in the displacement of dwelling houses by university buildings and a need for additional residence territory.

In his opinion, Federal Judge John B. Sanborn expressed the conviction that the property of the four complainants was of little value for "multiple dwellings" and that its value for industrial purposes is five to eight times as great as it would be for dwelling house purposes. The judge states as his feeling "that, while the public convenience —or at least the convenience of that portion of the public living in the section of the city where these properties lie—authorized zoning of the property as 'multiple dwelling,' the ordinance has seriously affected the value of this property, and is, from our standpoint at least, an unjust and unfair way for the city to limit the use of this property." The judge points out that under the general laws of Minnesota "the city of Minneapolis could have established a restricted residence district to include this property and could have secured to the complainant just compensation for any injury done. The police power has in this instance been used for the purpose of depriving the complainants of the most valuable use of their property, for the public benefit and convenience, without compensation." Notwithstanding this, Judge Sanborn goes on to say:

Theory of Zoning Ordinances

"The theory of zoning ordinances is good. In my opinion, in practical operation, they must almost necessarily give far too little consideration to the rights of many individual property owners, and will, in many cases, in practical effect, seriously depreciate the value of property, for which depreciation an owner, in common decency, should be compensated either by the municipality or by those whose property is specially benefited." Nevertheless, Judge Sanborn added, "zoning ordinances which, in theory at any rate, are carefully prepared by planning commissions and adopted after careful study by city councils, would not be benefited by having the judges of the federal courts substitute their judgment for that of the legislative bodies and attempt to revise them with respect to individual cases." At this point he refers to Zahn v. City of Los Angeles, already mentioned.

In dismissing the bill of complaint, Judge Sanborn finally said that "I cannot say that it is 'plain and probable' that the restriction placed upon the use of [this] property by the city 'has no real or substantial relation to the public health, safety, morals, or to the general welfare' or that 'the validity of the legislative classification for zoning purposes' is not 'fairly debatable.'"

The complainant in the case (Syver Lowe v. City of Minneapolis) decided by the same judge the following day, sought to establish an oil-filling station in a district zoned as residence, the filling station to be located on a triangular piece of property some 2,600 ft. in area, "vacant, although closely adjacent to it Mr. Lowe has a residence." The judge was of the opinion that for residence purposes the land in question had "very little value" while as a site for an oil-filling station "the evidence indicates that it is worth at least $20,000." The land in question is at the corner of a residence street and a business street, so that, in the opinion of the judge, it is "debatable whether it should be zoned for residence or business purposes." The decision gave the residence property and the city authorities the benefit of the doubt.

Intensive Safety Campaign Is Planned for October by Road Builders Association

Daily press releases from Oct. 1 to 14, an educational campaign to be carried on in some 25,000 churches, 15,000 schools, 5,000 civic clubs and 5,000 industrial organizations and miscellaneous institutions and the co-operation of approximately 300 mayors, 20 governors and a number of nationally known officials comprise the plans for a highway safety campaign which begins Oct. 1 sponsored by the American Road Builders Association. The first press release has been prepared by Charles M. Upham and summarizes the accident situation.

As a vehicle for carrying on the safety campaign during the next year, the American Road Builders Association has organized a highway safety club to which all men, women and children are invited to join. In stressing the necessity for a campaign of safety, the Road Builders Association points out that more than 7,000 children under 15 years of age are killed annually, and approximately 175,000 seriously injured. Highway accidents generally, it is pointed out, caused the death of more than 25,000 persons during 1926.

Among the organizations which are officially co-operating in the campaign are the Federal Council of Churches embracing 28 Christian religions in the country. The Rotary, Kiwanis, Optimist and Lions clubs throughout the country are going to assist by holding highway safety programs at regular meetings.

Building Record for Canada

A bulletin issued recently by the Canada Cement Co. states that the magnitude of the Canadian International Paper Company's construction program is indicated by the fact that 750,000 cu.ft. of concrete were poured in 1926, a construction record for Canada, unequalled in any year by any other company, municipality, provincial government or the federal government.

Cities of United States with Zoning Ordinances Totaled 553 on July 1

The number of cities in the United States which had adopted zoning ordinances on July 1, 1927, totaled 553 according to a summary made public by J. M. Gries, chief of the Division of Building and Housing, U. S. Department of Commerce. These municipalities range in size from New York City, which adopted the first comprehensive zoning ordinance as lately as 1916, down to places of less than 1,000, of which 49 are included in the list. Of the 68 cities of the country having a population of 100,000 or more, 52 have zoning ordinances in effect. A comprehensive zoning ordinance is being prepared for Louisville, Ky., and zoning studies are being made for Philadelphia and Detroit, the two largest unzoned American cities. The total population under zoning ordinances is over 30,000,000, or more than 55 per cent of the urban population of the United States.

Distribution of zoned municipalities by states is thus given by Mr. Gries: New York, 93; New Jersey, 75; Illinois, 56; California and Massachusetts, 54 each; Pennsylvania, 32; Ohio, 29; Wisconsin, 22; Michigan, 19; Indiana, 15; Connecticut, 12; Iowa and Rhode Island, 9 each; Kansas, 6; Missouri, North Carolina and Virginia, 5 each; Nebraska, 4; Colorado, Minnesota, North Dakota, Oklahoma, Oregon and Washington, 3 each; Alabama, Arizona, Arkansas, Georgia, New Hampshire, Tennessee and Utah, 2 each; Delaware, the District of Columbia, Kentucky, Louisiana, Maine, Maryland, Nevada and South Carolina, 1 each.

Forty-six states and the District of Columbia have laws which permit at least some of their municipalities to zone themselves. Of the 46 states mentioned, 28 have used all or a large part of the "standard state zoning enabling act," drawn by the Advisory Committee on Zoning of the Department of Commerce, and first issued in 1924.

Structural Building Stressed at Welding Society Meeting

(Continued from p. 523)

prehensive comparison of designs of riveted and of welded joints as applied to such plate work as tanks, hoppers, chutes and bins, air ducts, flues, breechings and stacks, ship work, as parts of structural members, and as parts of machinery members where plate work is being substituted for castings. Mr. Sforzini, while not proposing welding for all plate work, states that one of the chief advantages is that very little fabricating equipment is required, this consisting at most of cutting and welding equipment, a standard plate roll, a drill press and a plate gear. He also stated that "leading questions of design to the welding shop is a chief cause for failure of welded work. The designer of plate work should pay as much attention to welded details as he formerly did to riveting details."

Besides the structural welding matters with regard to building construction, aircraft welding was an outstanding feature of the meeting. As illustrative of this was the paper on "Welding the Aircraft Structure" by J. D. Johnson, chief, material branch, war department, air corps, McCook Field. Almost every aeronautical engineer in the country has adopted welding for steel airplane structures and welding structures have been used over five years on every type of military airplane. Welding has found most application in the fuselage, the landing gears and the tail surfaces, the wings being better adapted to wood or light aluminum alloy construction. The problem of a light metal wing structure could probably be solved if the aluminum alloys could be welded without a serious loss in strength. Alloy steel in airplane structures has been for the most part 3½ per cent nickel steel, but is rapidly being replaced by chrome-molybdenum steel which has excellent weldability. Carbon steel tubing is entirely satisfactory for small airplanes but the alloy steel in the larger types gives a reduction in weight.

Observations on Metallurgy

The quality of the steel welded and of the electrode used has such a marked influence upon the properties of the weld that the paper "Some Metallurgical Observations on Welding" by G. R. Brophy, Research Laboratory, General Electric Co., was timely.

In using bare electrodes, Mr. Brophy stated that the so-called cored electrode is most satisfactory considering arc stability and general smoothness because the core melts or at least it removed faster than the rim, thus giving a concave tip, the projecting edges of which confine the arc. Three reasons why the cores melt the faster are listed: (1) Difference in condition of the carbide in the core and in the rim; (2) higher carbon content in the core than in the rim; (3) higher slag content in the core than in the rim. Electrodes heavily coated with various materials such as paper, asbestos and other slag mixtures have been used satisfactorily these heavy coatings acting primarily as mechanical shrouds, forming a protection for the arc. With regard to plate stock, Mr. Brophy states that "the poor quality of most is outstanding, wide variation in carbon content being most common." This is especially serious since the carbon content of the parent stock has considerable influence on the strength and ductility of the weld. He concludes, however, that "fortunately good quality of steel is obtainable at little if any increase in price." Special attention should be paid to annealing of welds, since the metal is essentially cast steel. The phenomenon which occurs in high carbon steels in the form of a migration of carbon in the plate stock to the zone of fusion can be decreased by increasing the welding current according to Mr. Brophy. With regard to gas shields, hydrogen was pointed out as probably superior to all other gases for purity of deposit. The use of an alcohol vapor as a shield was described as having the advantages of convenience and lower arc voltages, and of giving ductile and strong deposit free from oxide inclusion. This method of using the alcohol is to allow the liquid to drip on and run down the electrode. At about ½ in. from the arc, the alcohol is vaporized and burns with a generous flame. Care must be taken that none of the liquid alcohol drops directly on the metal, because if this happens there is an explosion which blows the metal out of the pool and leaves a large depression in the bead. In conclusion, he said that "the most satisfactory results are obtained with bare or polished electrode wire even though the arc is rather rough; and that oxide is the chief embrittling agent in ordinary open-arc welding."

New Unified Transit Plan Submitted by Untermyer to New York City Officials

A plan for a "unified transit system" in New York has been submitted to the city officials by Samuel Untermyer, special counsel of the Transit Commission. Briefly, the plan proposes that the city recapture all the subway lines of the Brooklyn-Manhattan Transit Co. in Manhattan and part of them in Brooklyn and that it purchase the east side subway on Manhattan Island from the Interborough Rapid Transit Co. These lines Mr. Untermyer proposes to unify with the new subways now under construction by the city to form a city-wide system which will be leased to a semi-public corporation known as the Board of Transit Control. Supervision of this corporation would rest in a board of directors made up of the chairman of the Board of Transportation of New York as chairman, the controller of the city, a third person to be named by the mayor, and five additional directors, to be named by the Chamber of Commerce or a like body in the four larger boroughs. These eight directors would elect a ninth who must be a railroad operating man. He would be president of the corporation and the operating head of the system.

Provision of funds for the purchase and recapture of existing lines are to be made possible by the elimination of self-supporting bonds from the city debt limit, both by court action and a constitutional amendment now pending.

Maintenance of the 5-cent fare has been written in as one of the essential features of the plan. Mr. Untermyer favors repeal of the present law which make it obligatory that the new subway, if municipally operated, be self-supporting.

The plan does not call for complete unification. All the old elevated lines in New York and Brooklyn are left on the hands of the two private companies and the west side subway in New York is left as an independent line.

Personal Notes

W. C. YOUNGS, New Orleans, La., having completed surveys for Chef Menteur and Rigolets bridges on the New Orleans-Mississippi highway (Old Spanish Trail), is now resident engineer for the Louisiana State Highway Commission on construction of the St. Charles Parish section of the Hammond-New Orleans lake shore highway.

HALE SUTHERLAND, associate professor of structural engineering at Massachusetts Institute of Technology, has returned to his work in the school after a year's leave of absence. During the past year he served as professor of civil engineering and head of the department at the engineering school at Robert College, Constantinople, Turkey.

HUGH TURRITTIN, who graduated in June from the civil engineering school of the University of Minnesota, is now an instructor in the mechanics department of the engineering school of the University of Wisconsin, at Madison. He spent part of the summer as materials inspector for the Minnesota State Highway Department and the rest of the summer with the U. S. Engineers at St. Paul, Minn., working on flood control.

ANDREW G. BRIGGS has been appointed resident engineer with the Kentucky State Highway Commission, with headquarters at Shelbyville, Ky. Mr. Briggs has been engaged in the design and construction of highways since 1917, having been with the Arkansas, North Carolina, and for the past four and a half years with the West Virginia state highway commissions.

EDWARD HYATT, JR., who has been chief of the division of water rights, state of California, has been appointed acting state engineer of California, to succeed Paul Bailey who resigned effective Sept. 1, and will serve until a permanent state engineer is appointed. Mr. Bailey is now engineer of the Orange County Flood Control District, as noted in these columns Sept. 8.

FRANK F. YODER has been appointed highway engineer of St. Clair County, Mo., to succeed L. L. GRIGGS, deceased.

PAUL A. LAUGHLIN has left the employ of the Missouri State Highway Department after five years as resident engineer on highway construction and as division engineer of surveys and plans of Division 10 with headquarters at Sikeston, Mo. Mr. Laughlin was educated at the Agricultural and Mechanical College of Texas, served in the World War, and was for one year county engineer of Madrid County, Mo.

LOUIS P. STRUBLE has been appointed assistant to the chief engineer of the Pennsylvania R.R., with headquarters in the railroad's office at Pittsburgh, Pa. Mr. Struble graduated in civil engineering from Lehigh University in 1909, soon entered the service of the Pennsylvania R.R. as a draftsman in the chief engineer's department at Pittsburgh, and, aside from some field work, has advanced through the positions of engineer in charge of construction, office engineer, chief draftsman, and assistant engineer to his new position as assistant to the chief engineer.

C. E. BORGNIS, of Milwaukee, Wis., has been appointed structural engineer by Klug & Smith Co., consulting engineers, having been employed as erecting engineer by A. O. Smith Corp., both firms of Milwaukee. Previously Mr. Borgnis was engineer of way and structures for the Wisconsin Public Service Commission at Green Bay, Wis.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF PORT AUTHORITIES, New Orleans, La.; Annual Meeting, St. Louis, Mo., Oct. 4-7, 1927.

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Meeting with American Public Health Association, Cincinnati, Ohio, Oct. 17, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Fall Meeting, Columbus, Ohio, Oct. 12-14, 1927.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; Fall meeting, Birmingham, Ala., Oct. 17-19, 1927.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION, Chicago, Ill.; Annual Meeting, Minneapolis, Minn., Oct. 18-20, 1927.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Dallas, Texas, Nov. 14-18, 1927.

ASPHALT PAVING CONFERENCE: Under the auspices of the Asphalt Association and Association of Asphalt Paving Technologists; annual conference Atlanta, Ga., Nov. 28-Dec. 2, 1927.

HIGHWAY RESEARCH BOARD, NATIONAL RESEARCH COUNCIL, Washington, D. C.; Annual meeting, Washington, D. C., Dec. 1 and 2, 1927.

THE WESTERN SOCIETY OF ENGINEERS had a paper on "Selecting the Type of Bridge" presented by Dr. J. A. L. Waddell at the meeting on Sept. 19. The future program includes "Illinois Coal for Making Coke and Gas," by Harold Rose, Oct. 3; and "Air-Right Developments in Chicago," by Joshua D'Esposito, Oct. 10.

THE NORTH CAROLINA SECTION of the American Water Works Association will hold its annual convention at Durham, N. C., Nov. 7 to 9. H. G. Baity, Chapel Hill, is secretary.

THE DULUTH, MINN., ENGINEERS CLUB devoted its initial meeting of the season, Sept. 19, to forestry. Thorvald S. Hanson, who is in charge of the Forest Experiment Station at Cloquet, Minn., spoke on "Reforestation in the Arrowhead Country." The officers of the club are: President, J. A. Noyes; vice-presidents, C. R. Jacobus and F. B. Cronk; secretary, H. W. Richardson; and treasurer, F. C. Baluss.

THE NATIONAL ASSOCIATION OF RAILROAD AND UTILITIES COMMISSIONERS will hold its annual meeting at Dallas, Texas, Oct. 18 to 21.

Obituary

CHARLES H. RUST, former city engineer of Toronto, Ont., died Sept. 22 aged 74 years. Mr. Rust was born in England and went to Canada when young. He entered the service of the city of Toronto in 1877 and in 1881 was made assistant engineer. In 1883 he became assistant city engineer in charge of sewers. The first survey and plans for the main drainage works of Toronto were made by him. He was acting city and deputy city engineer from 1891 to 1898, and in the latter year was made city engineer. In 1906 he went to England to study sewage disposal. He resigned in 1912 to become city engineer of Victoria, B. C., where he had charge of developing a new water supply. He returned to Toronto in 1918 and was for some time engaged in work for the local street railway and electric light companies. Mr. Rust was president of the American Society for Municipal Improvements in 1902, president of the Engineering Institute of Canada in 1911, and in 1913 and 1914 a vice-president of the American Society of Civil Engineers. He was also a member of the executive committee of the American Water Works Association.

S. L. MAY, Evansville, Ind., president of the National Contract Co. which has constructed under contract with the federal government several of the locks and dams in the Ohio River, died Aug. 24 from injuries received in an automobile accident at Princeton, Ind. The work done by his company is said to extend to every district on the river.

HERMAN N. JOHNSON, contractor, Portland, Ore., was recently killed by falling from a railroad train near Tacoma, Wash. Mr. Johnson was 38 years of age. He was secretary of the Johnson Contracting Co., president and treasurer of Johnson, Gardner & Co., and a member of Myers & Co., all contractors, of Portland, Ore.

ADOLPHUS M. BUCKLEY, chief inspector of the work of the U. S. Engineers at Lock 6 on the Allegheny River, died Aug. 30 as the result of an injury received while inspecting a cofferdam. A hole had been cut in a steel sheetpile cofferdam and while Mr. Buckley was examining the lower stubs of the cut piles the upper section of the piles fell, injuring him. He was 29 years of age and his home was in Hopkinsville, Ky.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Views on Developments in Wire Rope Socketing

Efficiency of Pre-formed Strands and of a Steel-Sleeve Soft-Metal Lined Socket Applied Cold

By H. C. Griswold, C.E.,
American Cable Company, Inc.,
New York City

MANY methods of anchoring wire rope have been used among which the most commonly known are the wire rope splice, clips or clamps of various designs, sockets employing a wedge where the wire rope is bent back upon itself or sockets where the wire rope is anchored in a conical basket by means of molten solder, babbitt or zinc. All of these foregoing methods of anchoring rope invariably result in damaging

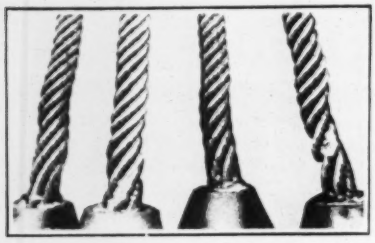


FIG. 1—WIRE ROPE WITH STANDARD SOCKETS SHOWING DISTORTION OF STRANDS

it to a certain extent. The Bureau of Standards has accepted a more efficient method which consists of brooming the wires of the rope, cleaning them and subsequently wedging them into the tapered bale of the shackle by means of molten zinc.

In Fig. 1 are illustrated the results of some of these methods of improper socketing showing the distortion of the lay of the rope due to the impossibility

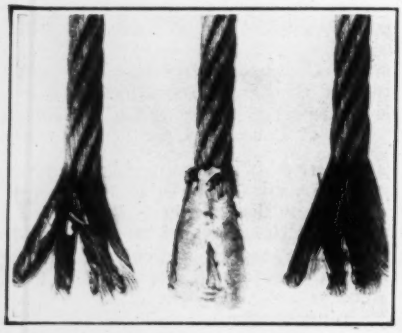


FIG. 2—PRE-FORMED WIRE ROPE AFTER REMOVAL FROM STANDARD SOCKET. STRANDS ARE NOT DISTORTED OR OUT OF PLACE

of securing equal tension on the strands. The development of a so-called pre-formed wire rope has reduced this detrimental effect to a minimum as is shown in Fig. 2 which illustrates three

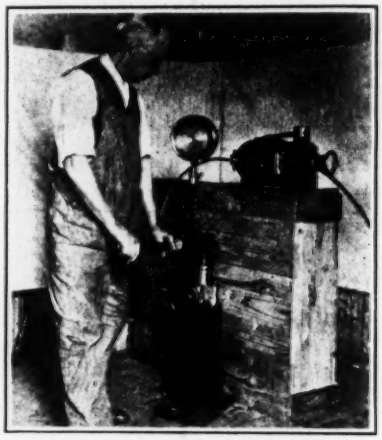


FIG. 3—APPLYING TRU-LOC BRAND SOCKET BY PRESSING ITS SOFT METAL LINING BETWEEN THE ROPE WIRES

ropes of a pre-formed type that have been removed from sockets applied in the ordinary way. The rope, as manufactured by the American Cable Co., is known as Tru-lay. It is called pre-formed rope because in the manufacturing process the wires and strands are "pre-formed" to the exact shape they

FIG. 4—THE PRE-FORMED STRANDS LIE IN THEIR ORIGINAL POSITION IN THE TRU-LOC FITTING

must have in the completed rope. Such a rope resists unstranding and can be cut at any point for splicing without the necessity of seizing because the wires are not distorted. Uniform tension throughout the rope is obtained.

To overcome some of the disadvantages of old methods of rope socketing, the American Cable Co. developed its Tru-Loc Brand processed fittings to be used with its Tru-Lay brand pre-formed wire rope. The Tru-Loc fitting consists of a steel sleeve with a liner of softer metal which is slipped snugly over the unseized end of pre-formed wire rope. Then by means of pressure, the inner lining is cold flowed around the rope so that the soft metal liner completely fills the interstices between the wires and strands, being held in position by the outer steel sleeve. No heating or cleaning of the wires is required.

The application of this sleeve to the wire rope is performed by means of a hand-operated press similar to that shown in Fig. 3. The outstanding feature of the sleeve is that it does not in any way affect the relationship of the wires in the strand. It has been tested in a wide range of applications

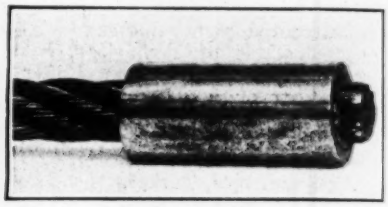


FIG. 5—A COMPLETE TRU-LOC BRAND SOCKET ON A STRAND OF PRE-FORMED WIRE ROPE

all of which have shown its high efficiency and uniformity. In one case a series of fatigue stress tests was made. These tests compared the efficiency of a Tru-Loc socket with a standard type of socket attached by brooming the wires, cleaning and wedging by means of molten zinc. Three different lots of standard sockets were tested, submitted to 200 stressings per minute with a load range from 0 to 4,000 lb. and back to zero per stress cycle. The three lots failed at 184,438, 173,447, and 276,025 applications of stress respectively. A Tru-Loc sleeve tested in like manner was removed from the machine after having run through 6,200,000 repeated stressings without failure.

The development of this sleeve applied by means of a portable press which can be readily operated in the field is believed to give engineers and rope users a connection which will in no way cause distortion of rope construction and which will insure the maximum of rope life and a higher efficiency both for rope strength and fatigue resistance.

Business Notes

Galion Iron Works & Mfg. Co., Galion, Ohio, is expanding its facilities. The Kansas City branch has recently moved into a large new building owned by the company while the branch at Orlando, Fla., has also just moved into a new building constructed especially for it. The board of directors of the company at a recent meeting authorized a new building, 90x340 ft., at the Galion plant.

Thew Shovel Co., Lorain, Ohio, announces that it has added five new men to its sales organization—James S. Griffin with headquarters in Denver will cover New Mexico, Colorado and Wyoming. E. L. Sparks, recently district manager in New York for the

Williams Bucket Co., will be in charge of sales in California. M. B. Garber has been appointed promotion engineer following his resignation as sales manager of the Sanderson Cyclone Drill Co. J. L. Trout has been assigned to Pennsylvania, Ohio and West Virginia territory; and P. A. McMillen has been added to the Chicago office.

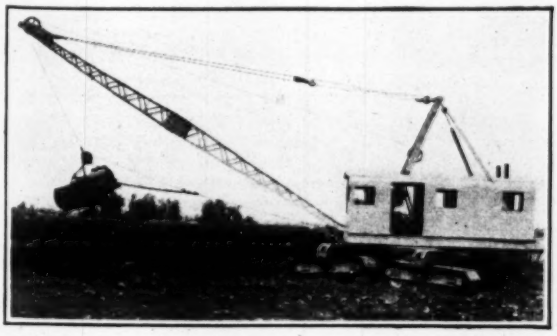
WELLMAN - SEAVER - MORGAN Co., Cleveland, announces the incorporation of an associated company in Canada, known as the Canadian Wellman-Seaver-Morgan Co., Ltd., with offices in Toronto.

PARADON MFG. Co., Arlington, N. J., announces that the following changes have been made in its sales organization: Paul M. Nickerson, formerly on sales and service work from the main office, has been appointed sales representative for the New England states and the state of New York, with the exception of the metropolitan area; Thomas M. Zimmerman, formerly of the state highway commission of Pennsylvania, will take care of sales in the states of New Jersey, eastern Pennsylvania, Delaware, and Maryland.

New Developments

Crawling Dragline Easily and Rapidly Moved and Erected

A new crawling dragline weighing approximately 65 tons and known as Model 411-C has recently been placed on the market by the Page Engineering Co., Chicago. The machine was designed with ease of erection and of dismantling strongly in mind. It can be shipped in three compact units exclusive of the boom and bucket and can be loaded on a flat car under its own power. It is claimed that the ease of loading on a flat car and speed of dismantling enable complete shipment to be made

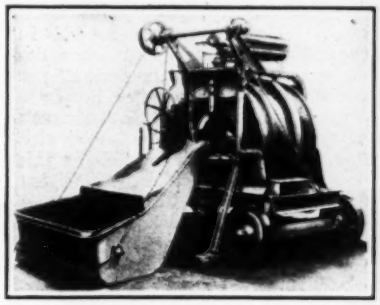


within two days' time. Also upon its arrival it can be completely assembled and unloaded in two days.

The propelling and steering mechanism allows the machine to move independently of all other operations. The crawler mounting is made up of four units built on structural frames. It is claimed they have sufficient bearing surface to take the machine over the softest ground without the aid of mats. Each unit is hinged in its center allowing vertical but not horizontal motion, thus enabling the machine to travel over very uneven ground. Each of the four units is driven by a chain drive. The overall length of two units is 25 ft. and the total bearing surface on each side is 33 in. by 23 ft. 4 in. Practically the same machinery is used on this new model as is used on the company's walking dragline. The company's Model B Diesel engine is used. The engine has been used for the last 3½ years, during which time it has been subjected to most severe tests of actual operation and is claimed to have given entire satisfaction not only on all Page machines but upon a number of other draglines.

Design of New 10-S Mixer Directed Toward Speed

A number of improvements in design mostly contributing toward greater speed in operation have been incorporated in the new 10-S mixer announced by the Marsh-Capron Co., Chicago. The machine has a two-bag capacity of



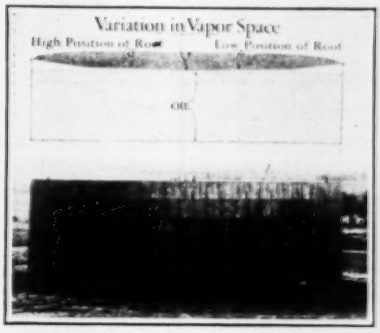
1:2:5 concrete. The improvements include a larger drum, a stream line power loading skip, a discharge chute of special design, Timken bearings in the drum rollers, and a stronger construction of the body frame.

The charging skip, which is 52 in. wide and 14 in. high at the back end, empties completely within 8 sec. after it has left the ground. Speed in charging is further increased by the large 23-in. charging opening of the drum. This opening is 3 in. greater than the standard drum. It is claimed that 10 sec. or less are required for the complete discharge of a full batch, due largely to the 20-in. discharge opening and the specially designed chute. This chute has a round bottom and straight sides. The round bottom is said to increase the discharge area about 30 per cent.

The position of the drum on the frame has been reversed so that as the machine is driven up in front of a job in line with traffic, the skip is toward the street and the discharging chute faces the job. One-man control is effected by placing banked levers at the side of the machine. Power is furnished either by two-cylinder or four-cylinder gasoline engines ranging from 6 to 10 hp. The tracks and drum roller shafts of the machine are guaranteed for its life while the drum roller bearings and the drum itself are guaranteed for a period of five years.

New Breather Roof Conserves Oil

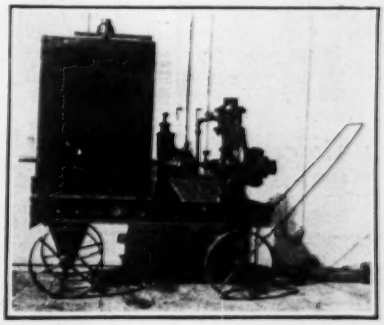
A new oil tank roof known as the Wiggins "breather" roof has recently been developed by the Chicago Bridge



& Iron Works, Chicago, Ill., as an aid in stopping evaporation losses. The roof is constructed of steel plates welded together the same as an ordinary steel roof. Its distinctive feature is that the roof framing is designed so that the roof, when resting on it, dips below the top of the tank shell. The roof plates are not fastened in any way to the roof framing and when the tank is full of oil and the small vapor space above the oil becomes heated, the vapor expands lifting the roof enough to take care of such expansion without allowing any of the vapor to escape. In the coolness of the evening the roof settles back to its former position.

Centrifugal Pumping Outfit Mounted for Portable Use

A new centrifugal pumping outfit is being introduced by the Ralph B. Carter Co., Hackensack, N. J., consisting of its "Humdinger" centrifugal pump driven by a gasoline engine and mounted on a steel truck. The pump case and impeller are gray iron castings. Extra



deep stuffing boxes and long bearings of the ring oiling type with ball thrust are used. Bearing brackets are cast as an integral part of the pump case, eliminating all possibility of misalignment. Bolted-on face plates give free access to the pump without disconnecting discharge pipe or removing shell from the base. The pump is equipped with a large capacity hand priming pump. These outfits are standardly equipped with Le Roi vertical enclosed gasoline engines in either 2 or 4 cylinder sizes, depending on the size of pump. The latter varies from 3 in. to 5 in. suction.

Manufacturers and Trade Associations

Calendar

Annual Meetings

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, New York; Annual convention, Pinehurst, N. C., Oct. 25-29.

NATIONAL ASSOCIATION OF MANUFACTURERS: Annual meeting, Chattanooga, Tenn., October 25, 26 and 27.

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington, D. C.; Annual Convention, Detroit, Jan. 4-6, 1928.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 16-19, 1928.

New Publications

Crushing Rolls—TRAYLOR ENGINEERING & MFG. CO., Allentown, Pa., has issued a new bulletin No. 2106 superseding its bulletin 1106 describing its heavy duty crushing rolls. The rolls are completely described and standard specifications are given illustrated with photographs of the various machine details. Size and capacity tables for the various types of rolls are given together with drawings and charts for computing capacities in the 41 pages of the bulletin.

Cement—MARQUETTE CEMENT MFG. CO., Chicago, has recently issued a 32-p. booklet, entitled "Concrete Evidence." It is a collection of photographs of many types of concrete construction built with Marquette high-test cement in the Middle West.

Asphalt Coating Tank—H. O. SWOBODA, INC., Pittsburgh, Pa., has published a small bulletin known as No. 108, describing its electrically heated asphaltum coating tank, designed for use in the manufacture of large pipe and similar products. The bulletin contains illustrations and description of the tank.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Low Bid on Argentine Tunnel 54 Per Cent of Next to Lowest

THE four bids recently received for a ten-mile water tunnel for the City of Mendoza, Argentine, ranged from $1,204,000 to $2,850,000, the next to the lowest being $2,240,000. The tunnel will be in main part through granite, with 1½ mi. at each end through sedimentary. It will be 6 ft. wide x 6½ ft. high.

Extending two miles through each end, a three-compartment shaft, 600 ft. deep, will provide working faces in addition to the adit working faces. The legal minimum wage is $1.70 u/s per day. Dynamite (62%) costs 42c. per lb., and power will be sold to the contractor at 1.7c. per kw.-hr.

All risks involved in timbering, pumping and concreting will be assumed by the Government. The Government also buys all machinery, paying for it as follows: 50 per cent on arrival in Buenos Aires; 30 per cent when delivered on the job; and the final 20 per cent, when the job is completed and the machinery returned to the Government's warehouses.

This is the third call for bids on this work. The City of Mendoza is in urgent need of the water, and since the previous bidding, a market has been found for the power which will be generated. The money realized from the sale of power will undoubtedly be sufficient to amortize the cost of the entire project.

The Government will probably decide to sign the contract within thirty days. The project is expected to require about four years for completion.

The price of the lowest bid is about half that of the next to lowest. It is likely, according to Mark R. Lamb, of the New York Steel Exchange, Inc., that this fact will result in the rejection of the lowest bid. The summary of bids follows:

	(1)	(2)	(3)	(4)
Per cu.yd. of shaft	$8.40	$20.80	$17.90	$26.00
Per lin.ft. of tunnel	23.00	41.50	48.50	53.00
Bonus or profit daily	213.00	255.00	130.00	85.00
Plant, machinery, houses, rails, power line	355,000.00	680,000.00	600,000.00	670,000.00
Shafts	54,000.00	135,000.00	116,000.00	170,000.00
Tunnel	$1,204,000.00	$2,240,000.00	$2,600,000.00	$2,850,000.00

Engineering News-Record urges its readers to send some of their own cost data to the Construction News Editor.

Overhead Percentage in Construction Cost

Analysis of the per cent of overhead costs in the contract prices of a number of buildings gives the following average values, according to a reader:

	Per cent
1. Tools and equipment	1.77
2. Field supervision	4.11
3. Gen'l office expense, salaries, rents	4.51
4. Field office, cement sheds, traveling, photographs	1.15
5. Insurance: public liability and indemnity	2.00
6. Insurance: fire	1.00
7. Contractor's profit	10.00
8. Contractor's bond	1.50
OVERHEAD	26.04
Materials	33.28
Labor	40.68
	100.00

Another reader submits the following percentage values for the chief three cost groups in the contract prices of steel bridges:

	Per cent
Labor	32
Materials	41
Overhead	27
Total	100

Engineering News-Record invites its readers to discuss these figures and to submit figures of their own—not only for buildings and steel bridges but for structures of all kinds.

These comments and figures will be published here, with or without names, as desired. They should be of great service to engineers and contractors.

Address Construction News Editor, *Engineering News-Record*, Tenth Avenue at 36th Street, New York, N. Y.

Business Briefs

Purchasing power of the building materials dollar was 61.6 cents in July compared with 58.3 the year previous, according to the Bureau of Labor Statistics. For specific building materials the July dollar was worth:

	First Half 1926	First Half 1927
	Cents	
Lumber	55.1	57.4
Common brick	48.9	48.6
Structural steel	75.5	85.1
Other	61.2	66.2
All	58.3	61.6

Irving Fisher's index number of wholesale commodity prices (100 = 1913) on Sept. 15 was 144.7, and the purchasing power of the dollar was 69.1 cents.

Sand, gravel and stone, hauled by the railroads of the country since Jan. 1 is 5 per cent greater in volume than for the same period in 1926.

Iron and steel pipes, tubes and fittings, imported during the first half of 1927, increased 98.4 per cent in tonnage, over imports for the same months last year.

Engineering News-Record Average Prices

Comparison With Year Ago Shows Decrease Of Slightly Over 2 Per Cent—Little Change From Previous Month

AVERAGE prices of six important construction materials in a number of cities have been computed for August, 1927, the month preceding and for August, 1926.

The average per cent change for all materials was an increase of 0.7 per cent over July and a decrease of 2.2 per cent compared with August, 1926.

These individual averages for August, 1927 (see table), showed less than 2 per cent change from the month preceding in all except 4x12x12-in. hollow tile, which increased 6 per cent. Compared with last year, sewer pipe and pine were 3 per cent and fir, 6 per cent lower.

Sewer pipe is quoted per ft., for standard, in carload lots, f.o.b. city.

Portland cement is per bbl., not including the cost of four bags, f.o.b., in carload lots to contractors.

Common brick prices are wholesale, in carload or cargo lots, f.o.b. city.

Hollow tile, 4 to 12-in. sizes, is per block, in carload lots, f.o.b., to contractors.

Douglas fir timbers are 3x12 to 12x12-in., 20-ft. lengths and under, per M ft. b.m., wholesale, f.o.b., in carload lots.

Long-leaf yellow pine timbers carry the same dimensions as fir and are quoted on the same basis.

The marked decline in the sewer-pipe price level as of August, 1927, compared with that of the same month last year, is due to reductions which occurred at Boston, New Orleans and Detroit. A slight stiffening of mill prices during the month, did not carry sufficient weight to counteract the downward trend.

A gain is indicated, in the accompanying table, for cement prices during August. This movement is seasonal and involves price advances in Boston, New Orleans, Los Angeles, San Francisco, and Baltimore.

Common brick prices declined in August, as shown by the table. This situation was largely due to heavy reductions at New York, Kansas City and New Orleans.

Average August tile prices were higher than those for the month preceding. Gains were largely due to upward movement in Philadelphia and Boston districts.

Pine and fir lumber declines were scattered and in sufficient number to cause a general slump in the market.

COMPARISON OF AVERAGE U. S. PRICES ON SIX MATERIALS

	No. of Cities	Aug., 1927	July, 1927	Aug., 1926	Per Cent Relation Aug., 1927 To July, 1927	Per Cent Relation Aug., 1927 To Aug., 1926
Sewer pipe, 12 in.	15	$0.472	$0.472	$0.4884	100	96.7
Portland cement	30	2.265	2.227	2.250	101.7	100.7
Brick	16	14.21	14.43	14.41	98.5	98.6
Tile, 4 x 12 x 12	17	.0894	.0839	.0916	106.6	97.6
8 x 12 x 12	16	.1659	.1656	.1695	100.2	97.9
12 x 12 x 12	8	.2335	.2347	.2320	99.5	100.6
Fir	11	37.73	37.89	40.33	99.6	93.6
Pine	14	51.04	51.32	52.62	99.5	97.0
Average					100.7	97.8

Unit Bids From Construction News

Three 500-hp. boilers for municipal service building in St. Louis for $37,078; brick settings, $12,876.

Twenty-five 80,000-gal. oil tanks have been ordered by the Mid-Kansas Oil & Gas Co., Del Rio, Tex., from the Mont Cooper Boiler & Iron Works, for $750,000.

Paving bids per sq.yd. were accepted recently as follows:

Cedar Rapids, Ia., crushed rock	$2.45
Cedar Rapids, Ia., gravelmg	1.49
Omaha, Neb., sheet asphalt	1.96
Wausa, Neb., reiu. concrete	2.35
Cedartown, Ga., concrete, 6-in.	2.70
Cleveland, Ohio, curb. and 2½-in. vitr. block	5.18

Bids were opened recently by the Azusa Irrigating Co., Azusa, Calif., for furnishing double dipped and wrapped Matheson joint steel pipe. The bids were as follows, per 100 ft.:

Feet	Size in Inches	(1)	(2)	(3)
2,000	3	$23.18	$24.13	$29.00
55,000	4	30.20	31.50	37.00
32,000	5	37.85	38.85	45.50
42,000	6	46.84	48.57	60.00
1,000	8	73.87	76.35	98.00
1,000	10	104.94	109.25	153.00

Brick Masonry Costs

THE accompanying tabulation of brick masonry costs was developed by John A. Mulligan, Inc., 2025 Broadway, New York, from records covering a period of twenty years. The labor constants given for setting brick have been taken from data of 12,688,000 brick. Mr. Mulligan writes: "Referring to mortar, our records show that 36.39 cu.ft. of sand, cement and hydrate are required to yield 1 cu.yd. of mortar (25.8 per cent being lost when water is added)."

To set 1,000 brick requires 0.75 cu.yd. of mortar, made as follows: 5.82 cu.ft. cement, 1.02 cu.ft. (51 lb.) hydrate, and 20.45 cu.ft. sand. Details follow:

COST DATA ON 12,688,000 BRICKS

Constants for hours or mortar

	Pieces 1,000 Sq.Ft.	Cu.Ft. Mortar	Mason Hours	Tender Hours	Foreman Hours	Hoist Hours	Sq.Ft. Average 8 Hours
2x 8x12	1500	.030	.059	.048	.003	.0018	135
3x12x12	1000	.027	.043	.028	.0015	.0013	186
4x12x12	1000	.036	.048	.032	.0016	.0014	166
6x12x12	1000	.055	.055	.036	.002	.002	145
8x12x12	1000	.074	.067	.049	.005	.003	119
12x12x12	1000	.108	.109	.078	.004	.0035	73
Enclosure Terra Cotta							
8x12x10½	700 each	.06	.067	.046	.002	.002	119
8x12x 5							
3½x12x10½	1143	.041	.067	.046	.0016	.0016	119
Gypsum							
2x12x30	400	.019	.043	.032	.0017	.0013	186
3x12x30	400	.027	.038	.032	.0014	.0013	210
4x12x30	400	.036	.048	.04	.0018	.0015	

Common Brick Data		Requirements for 1,000
Brick	12,688,000	
Bricklayers	92,315 hours	7.25 hours
Laborers	82,448 hours	6.50 hours
Hoist	494 days	.03 days

Face and Court Work—Constants give hours for labor		1 Cu.Yd. Mortar—(Labor ½ hour)	
Bricklayers	.015	Sand	27 cu.ft.
Laborers	.0125	Hydrate	1.35 cu.ft.
Foreman	.0009	Cement	7.65 cu.ft.
Hoist	.01045		
		Dry aggregate before adding mortar and mixing	36 cu.ft.

Mortar Requirements for 1,000 Brick—(19.3 cu.ft. mortar)		
Hydrate	1 cu.ft.	50 lbs.
Cement	5.5 cu.ft.	517 lbs.
Sand	19.5 cu.ft.	
	26 cu.ft. aggregate = 19.3 cu.ft. mortar.	

.8 x Bricklayer hours = laborer hours
.06 x Bricklayer hours = foreman hours
.03 x Bricklayer hours = hoist hours

Building Permits Average $47 Per Capita for 80 Cities

Permits issued during the first half of 1927 in eighty cities having a population of at least 100,000 averaged $42.94 per capita for new buildings and $4.28 for repairs, according to the Bureau of Labor Statistics. Of these cities seventy-eight reported last year, and show a decline of 6.3 per cent.

These seventy-eight cities provided dwellings in new buildings for 201,685 families in the first six months of 1926 and for 187,133 families in the first six months of this year. This is a reduction of 7.3 per cent.

In these eighty cities families were provided with homes in new dwellings at the rate of 58.2 families to each 10,000 of population. The following cities were the five leading home builders in the first half of 1927, and the ratio shown is the number of families provided with homes to each 10,000 of population based on the population as estimated by the Bureau of the Census for July 1, 1927—Yonkers, 172.4; San Diego, 132.8; Flint, 121.3; Fort Worth, 110.7; and New York, 99.2.

This Week's Contracts—With Comparisons

Minimum costs observed are: $15,000 for water-works and excavation, drainage, irrigation, levee, river and harbor projects; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, institutional, religious and other buildings.

Week ended	Public Work	Private Work	Total U. S.
September 29, 1927.	$36,390,000	$38,850,000	$75,240,000
September 22, 1927.	28,825,000	24,659,000	53,484,000
September 30, 1926.	23,317,000	34,994,000	58,311,000
Jan. 1 to date			
1927	966,659,000	1,402,276,000	2,368,935,000
1926	852,660,000	1,325,665,000	2,178,325,000

E.N.-R. Index Numbers

On September 1, 1927

COST	VOLUME
203.60	306
Last Year 208.30	Last Year 252

The Index Numbers are published in detail and with charts in the first issue of each month. The Cost Index is given in full from 1903 through 1926, with a thorough explanation of its method of computation, and a graphic comparison with many other index numbers, in the 48-page pamphlet entitled Engineering News-Record Construction Costs.

Weekly Construction Market

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, per 100 lb.	$3.34	$3.75	$4.00	$3.10	$3.35	$3.87½	$3.10	$3.00	$4.00
Structural rivets, per 100 lb.	5.00	4.00	4.75	3.60	3.85	4.64	5.50	5.25	5.50
Reinforcing bars, per 100 lb.	3.24	2.99	2.75	2.50	2.87½	3.77½	2.95	3.00	3.57
Steel pipe, black, 2½ to 6 in., lap weld, discount from list	48%	40%	54%	51%	48%	41%	42@53.8%	48%	.....
Cast-iron pipe, 6 in. and over, per net ton	—42.60	36.50	54.00	40.20	42.50	56.50	—41.00	55.00	41.00
Concreting Material									
Cement, without bags, per bbl.	2.35†	2.40	2.05	2.05	2.22	2.85	2.51	2.65	1.41
Gravel, ¾ in., per cu.yd.	1.75	2.20*	2.38	2.00	1.25*	1.90	1.80	1.25	1.90*
Sand, per cu.yd.	1.00	1.75	2.00	2.00	1.25†	1.00	1.40	1.25	1.35*
Crushed stone, ¾ in., per cu.yd.	1.85	2.50*	2.83	2.00	1.25*	2.50	1.70	3.00	2.00*†
Miscellaneous									
Fir, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.	.....	.....	.....	38.50(S&S)	36.75@38.75	34.25	27.00	—24.00	55.00†
Pine, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.	+65.00@62.00†	34.00	56.00†	.....	.....	.....	.....	.....	.....
Lime, finishing, hydrated, ton	17.45	24.50	19.00	20.00†	25.50	24.00	27.50	24.00	21.00
Lime, common, lump, per bbl.	2.10@2.35‡	1.35	1.82	1.50†	1.70	2.70‡	1.70	2.80‡	10.00*
Common brick, per M	16.00@18.00†	12.50	13.60	12.00†	13.75†	8@12	14.00	14.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0724†	.103	.....	.072	.085	..	.10	.10
Hollow partition tile, 4x12x12, per block	.1027	.0724†	.103	.076†	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	.86¼	87¾	.85	—.78	.90¾	1.01	.92	.98	1.03
Common Labor									
Common labor, union, per hour.	.90⅜	.30	.....	.90	.....	.....	.62½	.70	.....
Common labor, non-union, hour.	.....	.25	30@.50	.82½	.45@.60	.31¼@.50	....	.62½	.30@.35

*Ton. †Delivered to job. ‡280-lb. net. +Advance. —Decline.

A MAJORITY of the current price changes in basic building materials shows that the market lacks seasonal firmness.

Average quotations for the country, taken at principal producing, distributing and consuming centers, reflect the steady downward trend that has characterized 1927. Materials most affected by declining tendencies are the following: brick, tile, cement, sand, crushed stone, slate surfaced shingles, sheathing, cast-iron pipe, fabricated structural steel, paint materials (except zinc oxide), window glass, and 1-in. common boards.

Prices are firm and unchanged in lime, wire nails, plaster and plaster board (gypsum), red cedar shingles, and 1-in. pine or fir flooring.

Principal advances of the last month occurred in prices of pine and fir two-by-fours, cypress shingles, steel pipe, steel bars, zinc oxide, slate and roll roofing.

A glance at the figures in the table at the top of this page will show the present direction of demand for construction materials. The fact that the general cost level is approximately 2 per cent below that of a year ago, stresses the net gain in volume of construction as shown by a larger total of money spent in contracts, this year to date, compared with last.

THIS limited price list is published weekly except in the first issue of each month and gives current prices on the principal construction materials in the chief cities. Valuable suggestions on costs of work can be had by noting actual biddings as reported in the Construction News and Unit Prices sections following.

The first issue of each month carries complete quotations for all of the basic materials and for the rest of the important cities, also wage rates for the principal building trades and common labor. The last complete list will be found in the issue of Sept. 1, the next on Oct. 6. Explanation of prices contained in the table will appear from time to time in this section; last shown Aug. 11, 1927, p. 247.

Construction demand is certainly not subsiding in any direction except that of speculative buildings. The consistent decline in prices of certain materials, in the face of firmness or actual advances in others, as noted in price comparisons since the first of the year, is due almost entirely to overproduction. Mill and warehouse reserves, in the materials showing advances, are uniformly small throughout the country.

Rails, fabricated steel structurals, and agricultural implement material are the most active items in the current steel inquiry. Steel mill operations are at least 25 per cent below a year ago. Buying is definitely slower, at the present time, in steel bars, structural shapes, tank plates, sheets (except black), pipe, and strips. The non-ferrous metals market is fully as depressed as that of steel. Bars, shapes and plates are $1.75 per 100 lb., base, Pittsburgh, for lots involving several carloads; a single carlot or less brings $1.85 per 100 lb.